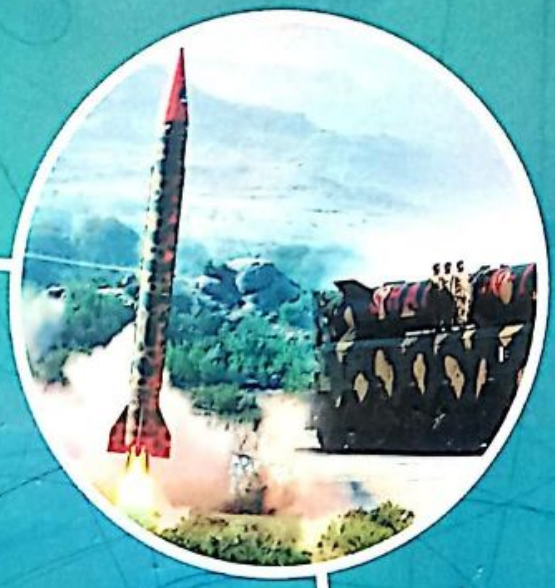

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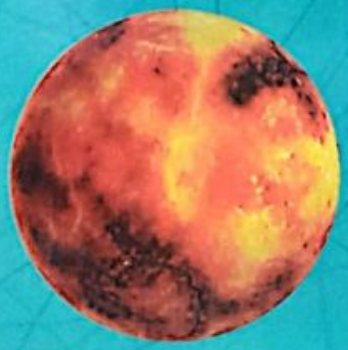

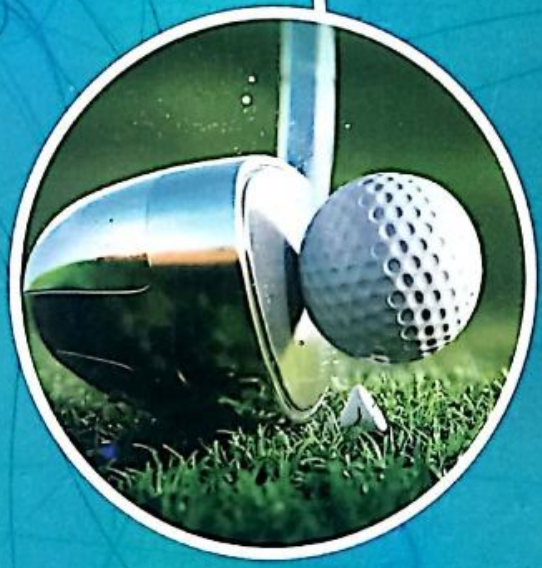

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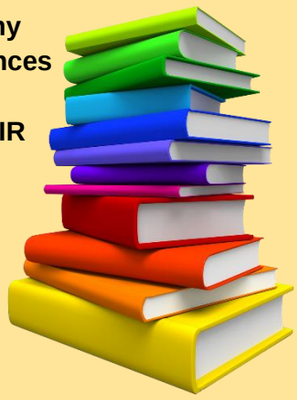

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اور اللہ سے ڈرتے رہو تا کہ تم پر رحمت
کی جائے"۔

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CONTENT

UNIT 1

ECOLOGY

Learning outcomes:

At the end of this unit, students will be able to:

- Describe the role of living things in cycling of oxygen and carbon through ecosystem, citing the process of respiration, photosynthesis and combustion.
- Relate how oxygen and carbon cycle are complementary processes that bring balance and symmetry to life on earth.
- Describe global warming and explain how it threats to the carbon oxygen balance such as overpopulation, reliance on fossil fuels and deforestation are contributing to global warming and climate change.
- Describe how energy flows from producers to consumers and how only part of the energy flows from one level of the pyramid to the next.
- Draw a food web diagram to illustrate the food relationship between organisms.
- Describe and illustrate through examples key ecological relationships between organisms including competition, predation and symbiosis.
- Predict how changes in an ecosystem (e.g., changes in the water supply, the introduction of a new population, hunting, migration) can affect available resources, and thus the balance among populations.
- Hypothesize what would happen in the ecosystem if the population of one of the participants in different ecological relationship is affected.
- Explain ways in which human behaviour (e.g., replanting forest, reducing air and water pollution, protecting endangered species) can have positive effects on the local environment.

Earth is the only known planet with life. Millions of species live on earth. These living organisms depend on each other in one or the other way. They also interact with their non-living environment. The study of interrelationship between organisms and their environment is called ecology.

1.1 OXYGEN CYCLE

Oxygen cycle plays an essential role in the existence of life on the earth. Few billion years ago there was no free molecular oxygen in the atmosphere. Today earth atmosphere has 21% oxygen which is largely product of photosynthesis carried out by plants. Plants use carbon dioxide to make food releasing oxygen as a byproduct.

Both animals and plants use oxygen in their respiration process to get energy.

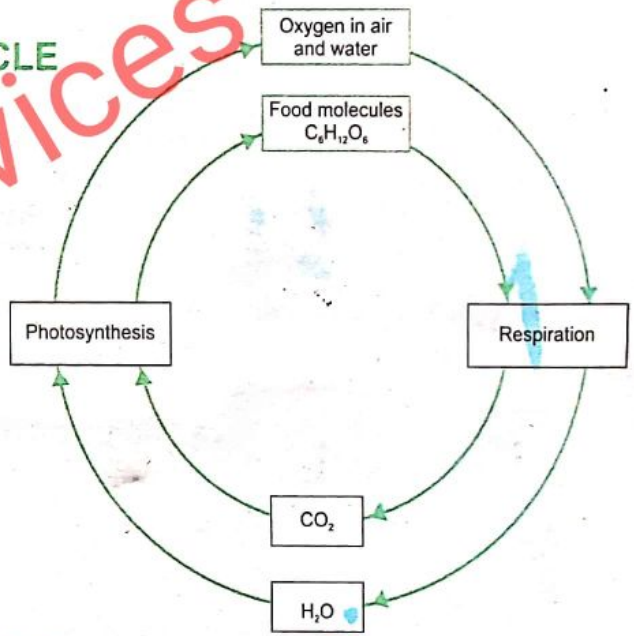


Figure 1.1 Oxygen Cycle

1.2 CARBON CYCLE

Carbon is constantly being removed from and released into the environment, in the form of carbon dioxide. The amount of carbon dioxide in atmosphere is 0.04%. Plants absorb this carbon dioxide to prepare their organic food by the process of photosynthesis. Animals gain carbon in the form of organic compounds when they feed on plants or other animals. The respiration process in both animals and plants releases carbon dioxide back to the environment.

A chemical reaction between substances and oxygen in which CO_2, heat and light is generated, is called a combustion reaction. Animal and plant bodies buried under earth crust were converted into fossil fuels like coal, oil and gas. The combustion of fossil fuels in factories, automobiles and houses is adding up carbon dioxide in the atmosphere rapidly.

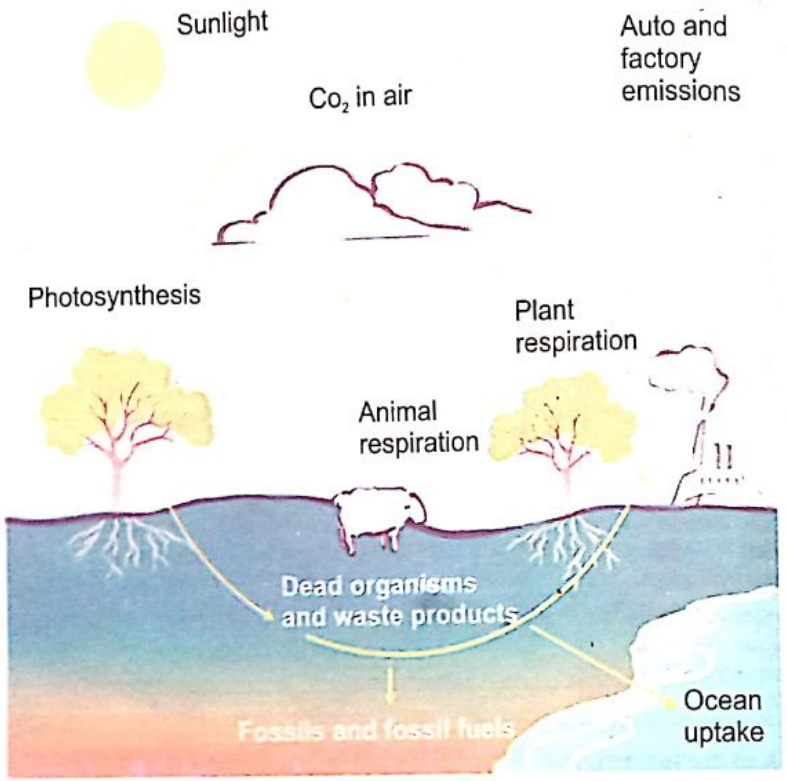


Figure 1.2 Carbon cycle

The oxygen cycle is interconnected with the carbon cycle. Oxygen is produced in photosynthesis and carbon dioxide is produced in respiration. Both these processes maintain the level of these gases in range to sustain life.

$$6CO_2 + 6H_2O \underset{\text{Respiration}}{\overset{\text{Photosynthesis}}{\rightleftharpoons}} C_6H_{12}O_8 + 6O_2$$

STOP AND CHECK

A drastic change in the level of either of these gases represents a serious threat to life. What will happen if the level of carbon dioxide continues to increase?

1.3 GLOBAL WARMING

The increase in average temperature of the earth is called global warming. The global temperature has increased by 1 °C in the last 100 years.

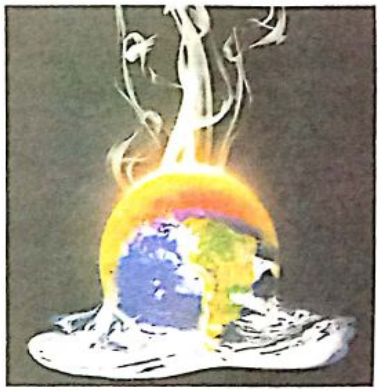


Figure 1.3 Global Warming

Causes

Human population growth is a major contributor to global warming. Due to the increase in human population the utilization of natural resources and the waste generated from the use of these resources has increased massively. Excessive use of fossil fuels and deforestation are leading causes of global warming.

The burning of fossil fuels such as coal, gas and oil is adding carbon dioxide in the atmosphere. Carbon dioxide is a leading greenhouse gas as it traps heat radiations.

Deforestation is the unplanned removal of trees on large scale which converts forest to non-forest land. Forests are removed to meet the increasing demand for land and materials. Major causes of deforestation are:

- Urban development / urbanization
- Infrastructure development like roads, rail tracks, air ports etc.
- Timber and fibre requirement
- Wood for fuel

DO YOU KNOW?

Greenhouses are huge structures made mostly of glass or plastic sheet.
Vegetables and fruits plants which cannot withstand cold can be grown in a greenhouse. Glass or plastic sheet traps heat energy to keep temperature higher than the surrounding environment.

TRY IT YOURSELF

- Visit a greenhouse near your home.
- Measure the temperature outside and inside the greenhouse.
- Name some plants growing inside the greenhouse.

Activity 1.1 Greenhouse effect

You can explore greenhouse effect in a simple activity. You need two thermometers, a stopwatch, and a glass jar with lid which can fit one thermometer.

Place both the thermometers next to each other in the sun. Set the stopwatch timer for five minutes. Read the temperature of both thermometers once the five minutes are over. Do both thermometers show the same temperature?

Put one of the thermometers in the jar and close its lid. Place jar next to the other thermometer in the sun for about 20 minutes. Note the temperature of both thermometers.

Did the temperature change?

Is the temperature higher inside or outside the jar?

Can you explain your result?

1.4 INTERACTIONS IN ECOSYSTEM

In an ecosystem, living organisms interact with each other in different ways. Most common interactions are competition, predation and symbiosis.

Competition

Competition occurs when living organism have to use common resources for their survival. Even members of the same species compete with each other for some resources.

Animals compete for food, water and space to live. Plants compete for light, water, minerals and root space.

Figure 1.4 Competition

Predation

In predation one organism attacks, actively kills and feeds on other organism. One which attacks and kills the other is called predator. Prey is the animal that is hunted and killed by predator for food.

Figure 1.5 Bear as Predator

Figure 1.6 Lion as Predator

Predator in one case can be prey in another case.

Figure 1.7 Frog as Predator

Figure 1.8 Frog as Prey

Some plants are also carnivorous. They prey upon insects and other small animals to fulfill their nitrogen deficiency e.g. pitcher plant and Venus fly trap.

Figure 1.9 Pitcher Plant

Figure 1.10 Venus Fly Trap

Symbiosis

In symbiosis members of two different species live together and at least one gets benefit from the other. Symbiosis has three types.

Parasitism

It is the association in which one member gets benefit and causes some harm to other member e.g. mosquito, liver fluke, leech and many types of bacteria.

Figure 1.11 Leech on Skin

Mutualism

You may have observed butterflies and honey bees in a flowered field of mustard. Can you name the interaction between insects and plants having brightly coloured flowers? Symbiotic interaction in which both members get benefit is called mutualism e.g. microorganisms in the gut of herbivores help to digest cellulose and get food and shelter in return.

Some bacteria live in intestine of man. They get food and provide us with some vitamins in return.

Figure 1.12 Honey Bee in Flower

Commensalism

In this type of interaction one partner gets benefit without any benefit or harm to other organism e.g. a bird building nest on a tree. Epiphytes are small plants which grow on large trees for space to get better light.

Teaching Point:

Teacher will discuss more examples of ecological interactions with students and their significance.

Figure 1.13 Epiphyte on Tree

UNIT 1 ECOLOGY

1.5 FLOW OF ENERGY IN AN ECOSYSTEM

An ecological system formed by the interaction of living organisms and their non-living environment is called ecosystem. The living organisms in any ecosystem are called producers, consumers and decomposers.

Producers have the ability to use light energy to produce food during photosynthesis. Plants and algae are producers of ecosystem.

Consumers are those which obtain energy by feeding on other organisms. All animals are consumers. **Herbivores** are primary consumers as they feed on green plants. Secondary and tertiary consumers feed on other animals so are **carnivores**.

Decomposers obtain energy by breaking down dead organisms and excretory products. Fungi and bacteria are examples of decomposers.

The feeding relationship between organisms can be represented in a food chain.

A **food chain** is a series of organisms through which energy is transferred in the form of food.

Producer → primary consumer → secondary consumer → tertiary consumer

Figure 1.14 Food Chain

However, in the ecosystem food chains are interlinked to form **food web**.

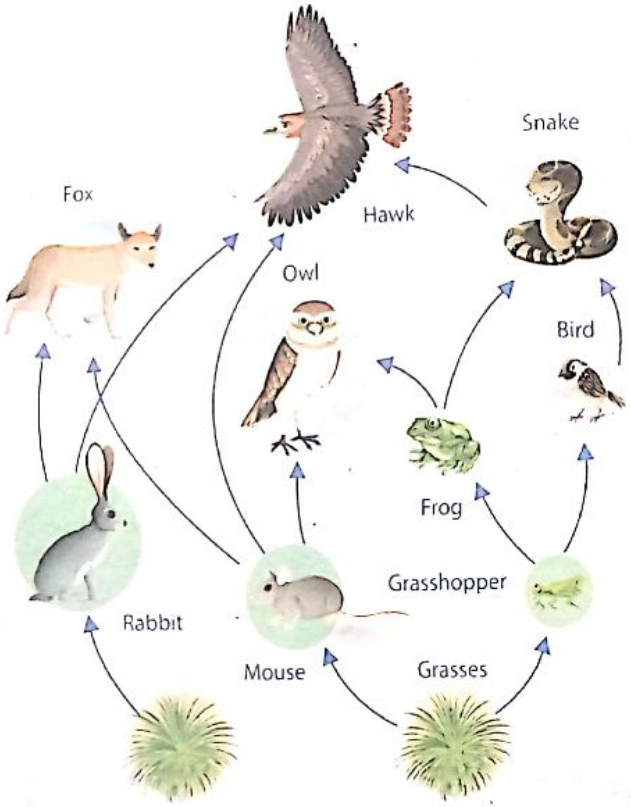


Figure 1.15 Food Web

A lot of energy is lost to the environment as food is transferred from one level to the next in a food chain. Energy may be lost to the environment:

- as heat during respiration at each level
- in uneaten body parts
- through food material which remains undigested, and
- through waste products excreted by consumers, for example urea.

More and more energy is lost as we go down a food chain. The total energy is highest at the producer level and lowest at the last level.

The total energy in the various levels of a food chain can be represented in form of a pyramid. This is called pyramid of energy. A pyramid of energy is always broad at the base and narrow toward the top.

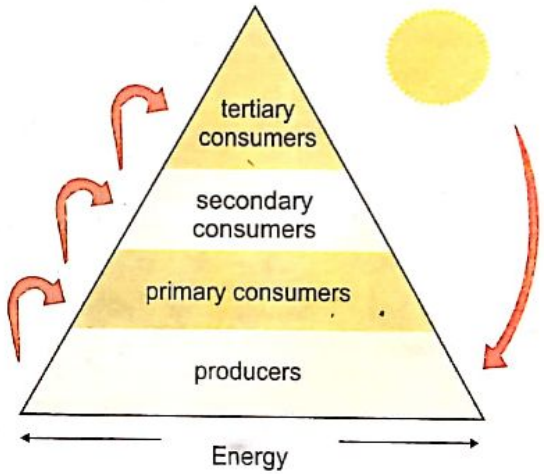


Figure 1.16 Pyramid of Energy

1.6 CHANGES IN AN ECOSYSTEM AND ITS EFFECTS

Changes in water supply

Water is the medium of life. All forms of life directly depend on water availability. Aquatic life on earth is 90%. Forests, wetlands and grasslands are critical part of the global water cycle. However, ecosystems are affected by floods and drought. Human impact on ecosystems has disturbed natural water cycles. The justified use of water and treatment of sewage water can have positive effect on ecosystem.

Introduction of new population

Living organisms are adapted to their environment. Introduced species are new organisms brought into an ecological environment. If introduced species cannot adapt to new environment it will not survive. However, if that new species find a way to survive, it affects all the other species already living there. It may result in death of one or more native species. With the passage of time ecosystem will reach to a new equilibrium.

Hunting

Nature has a delicate balance and human hunting can have impact on that natural balance. It is one of the causes of species extinction. If a predator is hunted their prey will increase in number. The decrease in the size of one population and increase in the other will change the ecosystem greatly.

Figure 1.17 Hunting of Birds

Migration

Sometimes animals migrate from one area to another to get better food sources. Migration may alter the structure of already settled populations.

Figure 1.18 Migratory Birds

1.7 POSITIVE IMPACT OF HUMAN ON ECOSYSTEM

A balanced ecosystem ensures that human beings have access to clean air, water and fertile land for agriculture. To save our planet and diverse ecosystems, a number of steps are being taken.

Reforestation

Reforestation is the plantation of trees where already existing forest has been destroy by some cause. It is very important as trees decrease toxic gases from the surrounding nature. Forests are natural carbon sink. By removing greenhouse gases from the air planned forests can reduce global warming. Reforestation is a solution of stopping soil erosion to maintain land quality. Forests support other plants and animal species, thus maintaining ecosystem.

Afforestation

Afforestation is plantation of forest on land where there was no forest before. It is very useful to increase forest land in Pakistan as we have very low forest coverage.

Before Reforestation — After One Year of Reforestation

Figure 1.19 Lahore (Balloki) Reforestation in 2019

Control of Pollution

The addition of harmful substances in the environment is called pollution. The unjustified use of resources has damaged environment badly. Major pollution causing substances are:

- Harmful gases and dust from factories
- Pollutants from power stations and automobiles
- Sewage from urban areas
- Use of plastics

Air and water pollution has badly affected all forms of life. However, many steps are being taken to control pollution which will ultimately help to conserve endangered species.

Control of Air Pollution

The shift on clean energy sources will help reduce air pollution and reverse its effect on the environment. The use of wind power station and solar energy is replacing coal and oil power station. Electrical vehicles are becoming popular day by day.

Figure 1.20 Harvesting Solar Energy

Figure 1.21 Harvesting Wind Energy

Control of Water Pollution

Protection of clean water resources is a challenge. Water conservation, treatment of sewage from homes and industry, and less use of plastic are key steps to control water pollution. Thus, more clean water will be available to keep ecosystem flourishing.

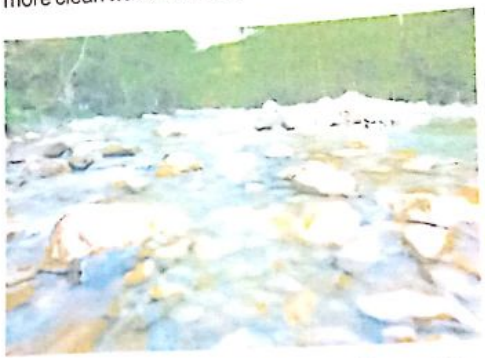


Figure 1.22 Conservation of Water Resources

Figure 1.23 Water Conservation

Conservation of Endangered Species

Plants and animals maintain the health of an ecosystem. When a species becomes endangered, it is sign that ecosystem is out of balance. Government, NGOs, local communities and individuals work together to contribute towards growing the population of endangered species. The awareness campaign aimed at getting more people involved in conservation work is very effective way for species conservation.

Figure 1.24 Panda

Figure 1.25 Pangolin

Teaching Point: Teacher will discuss how balanced ecosystem is necessary for the survival of human and planet earth.

UNIT 1 ECOLOGY

Key Points

- Continuous recycling of oxygen and carbon in the earth environment is vital process of nature to sustain life on earth.
- Photosynthesis and respiration run in opposite way to keep oxygen and carbon dioxide in balance.
- We are facing the challenge of global warming due to overpopulation mainly.
- Living organisms interact with each other in different ways to get benefit.
- All pathogens are parasites but all parasites are not pathogens.
- Green plants are producers which prepare food by photosynthesis.
- Animals are consumers which depend on plants directly or indirectly.
- Major portion of energy is lost in one to next level of food chain.
- There is a need to take steps to conserve nature.

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. The process which consumes carbon dioxide and produces oxygen is
   a. respiration. b. combustion. c. photosynthesis. d. fossilization.
2. Greenhouse gases
   a. burn to add heat. b. trap heat.
   c. help heat to escape. d. do not allow heat to reach earth surface.
3. The interaction in which both members get benefit from each other is
   a. mutualism. b. predation. c. commensalism. d. competition.
4. The organism that kills the other for food is called
   a. prey. b. parasite. c. pathogen. d. predator.
5. Rhizobium is a group of bacteria which live in the roots of some plants. They fix nitrogen for plant and get food in return. This relationship is
   a. parasitism. b. commensalism. c. mutualism. d. competition.
6. In a food chain, which type of organisms utilizes most of the sun energy coming to earth?
   a. Producers b. Primary consumers
   c. Secondary consumers d. Tertiary consumers

7. In an ecosystem, the energy flow is always
   a. bidirectional. b. random. c. down in a pyramid. d. unidirectional.
8. Carnivorous plants feed on insects because these plants grow on marshy places deficient in
   a. carbon. b. nitrogen. c. calcium. d. iron.
9. Greenhouse traps
   a. carbon dioxide. b. heat. c. light. d. water.
10. The most common non-biodegradable pollutant is
    a. wood. b. leaf litter. c. bodies of dead animals. d. plastic bags.

B. Short questions

i). What are the major causes of pollution?

ii). Differentiate between primary and secondary consumers.

iii). What is mutualism? Give some examples.

iv). Enlist the ways to control air pollution.

v). Why sewage water must be treated before releasing it into streams?

vi). How can you grow plants of warm area in a region with low environmental temperature?

C. Long questions

1. Explain carbon cycle and find the reasons for the gradual increase of carbon dioxide in atomsphere.
2. How positive activities of human can help to restore an ecosystem.

D. Structured response questions

1. Blind Indus dolphin is endemic to river Indus. It is an endangered species of water animal in Pakistan.

a. Enlist the factors which lead to the threat of extinction of Indus dolphin.

b. What is the present status of this mammal?

c. Suggest the steps to help conservation of Indus dolphin.

2. Most of the islands of Maldives are less than one meter above the sea level.

a. What could be the effect of global warming on such islands across the globe?

b. Suggest the ways to save coastal cities from flooding or being submerged.

E. Project work

Use plastic plants / grass and animals to make a model of food chain.

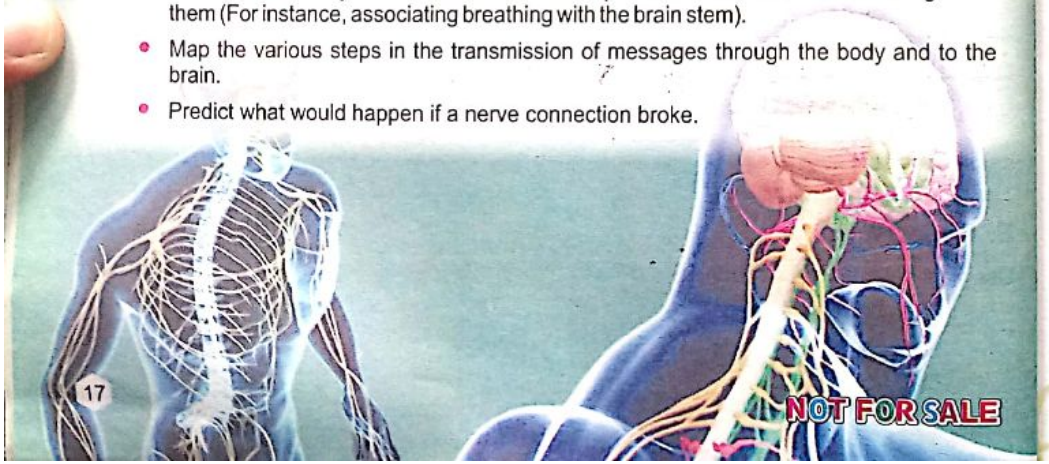
UNIT 2

HUMAN NERVOUS SYSTEM

Learning outcomes:

At the end of this unit, students will be able to:

- Identify the organs, functions and processes of the Human Nervous System.
- Sketch and label a diagram of the Human Nervous System.
- Explain how the brain works as the control station of the human body.
- Identify the three major parts of the brain –cerebrum, cerebellum, the fore brain, mid brain and hind brain, & describe their various functions.
- Describe the structure of the cerebrum, its division into two hemispheres (left and right) and the role of each hemisphere in the control of the body.
- Map the various steps in the transmission of messages through the body and to the brain via a reflex arc.
- Describe the types and function of neurons in transmitting messages through the body.
- Create a plan of activities and exercises they can do to maintain a healthy brain.
- Match various body functions with the relevant part of the brain that controls or regulates them (For instance, associating breathing with the brain stem).
- Map the various steps in the transmission of messages through the body and to the brain.
- Predict what would happen if a nerve connection broke.



Various organs of human body play their role as and when required. These organs perform their duties in a precise way in harmony with each other. For example, heart rate and breathing increase during exercise to meet energy requirement of the muscles. However, organs cannot work properly by themselves. They require some signal for proper functioning. Therefore, nervous system coordinates and regulates all the body functions.

2.1 NEURON

Nervous system is made up of cells called neurons. Neurons conduct messages in the form of electrical signals called nerve impulses.

Dendrites are fibres of neuron which transmit nerve impulses to the cell body.

Cell body is the thick part of neuron which has nucleus and most of the cytoplasm.

Axon is the neuron fibre which transmits nerve impulses away from the cell body.

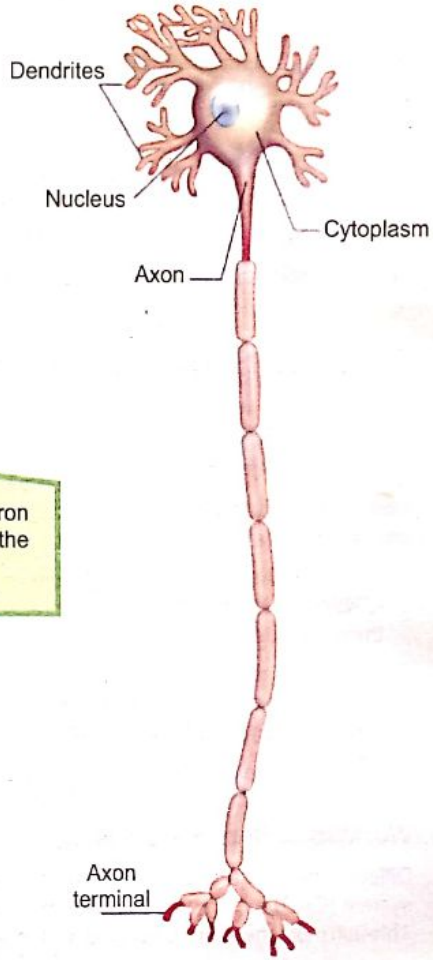


Figure 2.1 Neuron

Types of Neurons

Neurons are of three types:

- Sensory neurons transmit nerve impulses from receptors to the central nervous system.
- Motor neurons transmit nerve impulses from the central nervous system to the effectors.
- Interneurons are neurons of the central nervous system. They transmit nerve impulses from sensory neurons to the motor neurons.

DO YOU KNOW?

- Any change in environment which has some influence on living organism is called stimulus.
- Sense organs or cells which receive stimulus are called receptors e.g., eyes, nose etc.
- A muscle, gland or organ capable of responding to a stimulus is called effector.
- The change in activity of the organism according to stimulus is called response.

2.2 PARTS OF HUMAN NERVOUS SYSTEM

Human body has very fast and precise method of communication in the form of nervous system.

The human nervous system can be divided into two parts:

1. The central nervous system (CNS) consisting of the brain and the spinal cord.
2. The peripheral nervous system (PNS) consisting of nerves which originate from brain and spinal cord.

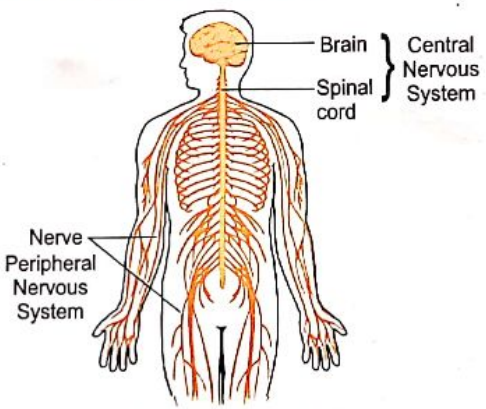


Figure 2.2 Nervous System

Working of Nervous System:

Different stimuli are detected by receptor organs. This information is conveyed to central nervous system (CNS) through sensory neurons. The CNS analyses the stimulus and takes decision. Through motor neurons, CNS orders effectors to act accordingly.

Stimulus → Sensory neuron → CNS → Motor neuron → Effector → Response

UNIT 2 HUMAN NERVOUS SYSTEM

Brain:

Brain is protected in human skull. It is divided into three main parts i.e. forebrain, midbrain and hindbrain.

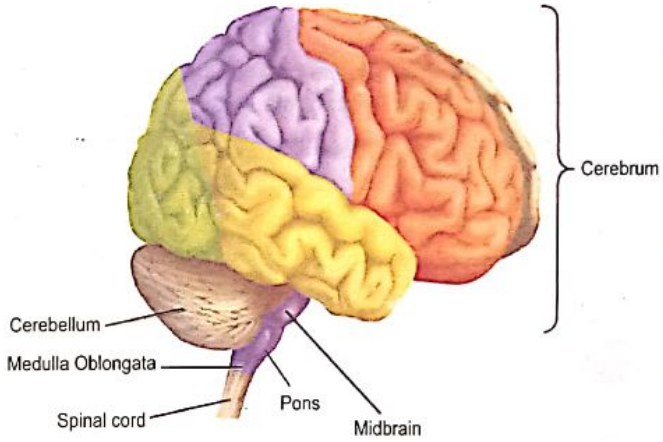


Figure 2.3 Brain

INTERESTING FACTS

The human brain is the most complex structure in the universe and it is far superior than any computer yet built.

Forebrain further consists of cerebrum, thalamus and hypothalamus.

Cerebrum is the largest part of brain. Human cerebrum is the most advance in all animals. It is divided into right and left hemisphere. Cerebrum is the site of conscious (our sense of self), memory, intelligence, learning, reasoning, personality, emotions and 'will'.

DO YOU KNOW?

The right cerebral hemisphere controls the left side of the body and the left hemisphere controls right side of the body.

Thalamus plays critical role in the processing of perception. It receives sensory information from the receptor organs and sends them to the specific part of cerebrum.

Hypothalamus regulates body temperature, appetite, water balance and blood pressure. It has centres to control mood and emotions, such as aggression, rage, fear and pleasure.

Midbrain is reduced in human. It serves as a link between forebrain and hind brain. It also controls the reflex movements of eye muscles.

Hindbrain consists of cerebellum, pons and medulla oblongata.

Cerebellum is concerned with the control and precision of all movements involving voluntary muscles.

Pons is a bridge between cerebellum and other parts of brain.

Medulla oblongata controls involuntary activities like heart rate, breathing rate, swallowing, vomiting, salivation, coughing and sneezing.

STOP AND CHECK

What will happen if pleasure centre of a person is suppressed?

Spinal cord

Spinal cord is a cylinder of nervous tissue running from the base of the brain down to the back. It is protected by the backbone. Brain links to most of the body parts through spinal cord. Many reflex actions are controlled by the spinal cord e.g. withdrawal of hand on touching hot object.

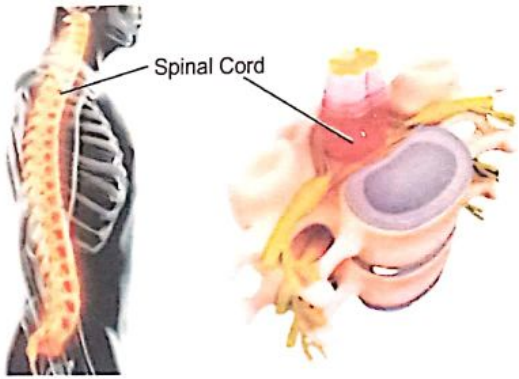


Figure 2.4 Spinal Cord

Spinal cord has a central butterfly shaped area called grey matter and outer to it is white matter. On the other hand brain has outer grey matter and white matter to its centre. Grey matter has cell bodies of neuron and non-myelinated fibres. The white matter has myelinated fibres.

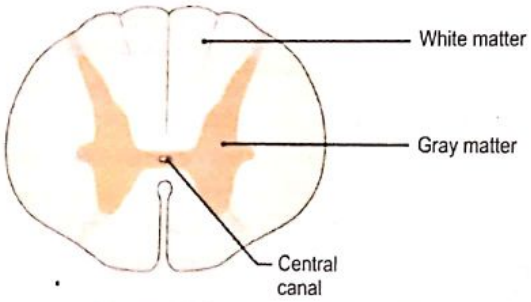


Figure 2.5 Section of Spinal Cord

UNIT 2 HUMAN NERVOUS SYSTEM

Peripheral nervous system

It is a system of nerves which link different body parts with the brain.

A nerve contains many fibers of sensory neurons, motor neurons or both protected in a sheath of connective tissue.

Cranial nerves: These nerves originate from brain. Humans have 12 pairs of cranial nerves.

Spinal nerves: These nerves originate from spinal cord. There are 31 pairs of spinal nerves in humans.

Activity 2.1 Animal's response to stimulus

Animals respond to stimuli as they have nervous systems.

You can check it through a simple investigation.

Materials required:

- Petri dish with lid
- Black paper
- Watch
- Termites (10 animals)

Procedure:

Cover one half of the petri dish with black paper to make that half dark.

The other side must remain uncovered and bright.

Put five termites into the bright side of the petri dish and five into the dark side.

Cover the petri dish with clear lid.

Note the time on your watch and observe the behaviour of termite after half an hour.

a. What is the distribution of termites in the bright and dark area of the petri dish?

_____

b. If all the termites move to the dark side of the petri dish, what is the stimulus that termites responded?

_____

c. If all the termites move to the dark side of the petri dish, what type of response is it; positive or negative?

_____

2.3 VOLUNTARY AND INVOLUNTARY ACTIONS

Activities which are performed willingly are called voluntary actions. On the other hand involuntary actions are not under our conscious control.

Try it yourself

Here are some activities you perform in routine:

Walking, sneezing, running, riding a bicycle, breathing, eating, reading, heartbeat, swimming, blinking of eyes and salivation.

a. Which of these activities are voluntary in nature?

_____

_____

b. Which of these activities are involuntary in nature?

_____

_____

c. Enlist some other voluntary and involuntary activities which you have experienced.

2.4 REFLEX ACTION

A sudden response to a specific stimulus without conscious control is called a reflex action.

A common example of reflex action is the withdrawal of hand on touching a hot object. What happens in your mouth when you smell/ look/ think of delicious food with an empty stomach? Have you ever noticed that shape and size of inner dark region of cat's eye changes? What happens to the size of inner dark region (pupil) of your eyes when you go to bright light?

2.5 REFLEX ARC

Reflex arc is a pathway on which nerve impulse travels from receptor to the effector.

The sequence of pathway of nerve impulse in reflex arc is as under

1. Sense organ (receptor)
2. Sensory neuron
3. Interneuron (in CNS)
4. Motor neuron
5. Effector (muscle or gland)

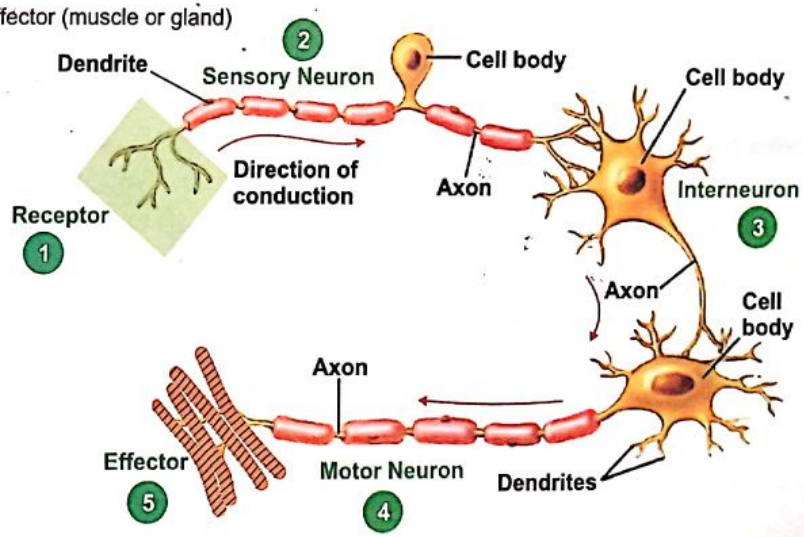
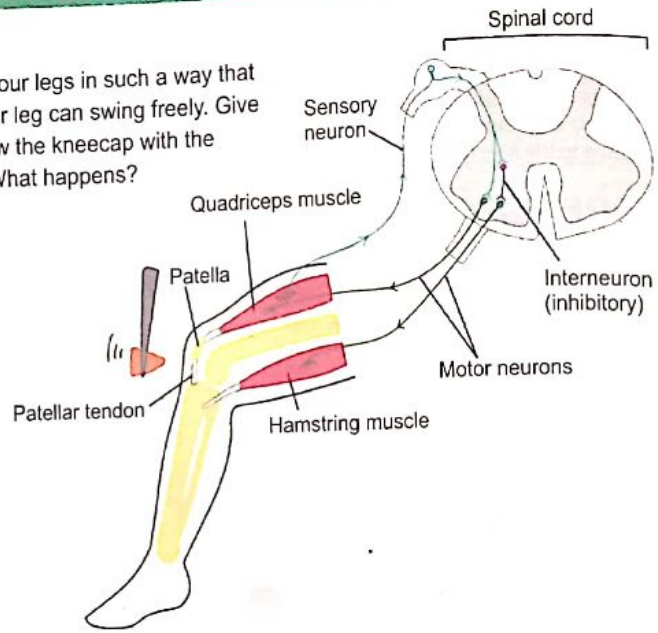


Figure 2.6 Reflex ARC

Teaching Point: Teacher should explain the significance of reflex actions.

Activity 2.2 The knee jerk reflex

Sit down and cross your legs in such a way that the shin of your upper leg can swing freely. Give a sharp tap just below the kneecap with the edge of your hand. What happens?



a. What feeling do you get in your thigh muscle?

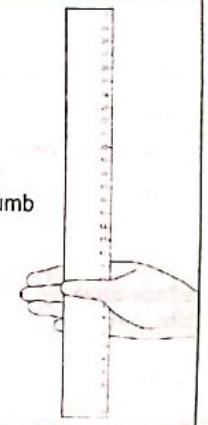
b. Is the kicking of your leg an automatic reaction?

c. Can you control it?

Activity 2.3 Reflex action time

Materials required;

Table Stool Ruler Stop watch



Procedure:

Student A will sit on the stool with his/her elbow on the edge of a table.
Student B will hold the ruler with the bottom of the ruler level with the thumb of first student.
Students B will drop the ruler.
Student A will catch the dropping ruler.
Students C will record the catching time of student A using stop watch.
It will show the reflex action time of student A.
Similarly record the reflex action time of at least ten students.

No	Student's Name	Distance covered by ruler	Reflex time
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

a. What is the reading shown in Figure?

b. Which student has shortest reaction time in your class?

c. What is the average reflex time of ten students?

d. Which student catches the ruler after longest distance covered by ruler?

2.6 ACTIVITIES TO KEEP YOUR BRAIN HEALTHY

Staying healthy is not only about exercising your body, but about exercising your brain as well. Your brain needs activity to stay healthy and to preserve memory.

Here are some activities you can do to help keep your brain sharp.

Learn: Never stop learning. Find ways to engage with others and educate yourself.

Answer questions: Put yourself in situations where you are required to think on your feet.

Try something new: Try new things that require your brain to learn and grow.

Debate: Debate without getting angry. A healthy debate forces you to think

Exercise: Any form of exercise increases blood flow to the brain and makes your brain more efficient.

Reduce stress: Do stress relieving activities like painting, offering prayer, yoga, mountain hiking, field games etc.

Notice the details: Take time to observe the sights and sounds around you, and then tell others about them.

Redecorate: Paint a wall in your home, rearrange your furniture and hang new pictures.

DO YOU KNOW?

Neurons can be damaged by pressure, stretching, or cutting. An injury to a neuron can stop the signals transmitted to and from the brain.

Symptoms of damage to nerves include:

- Loss of movement
- Loss of sensation
- Pain or stinging sensation
- Difficult breathing

UNIT 2 HUMAN NERVOUS SYSTEM

Key Points

- Nervous system interlinks different body parts to work according to the body needs.
- Stimulus is the change in environment and response is change in activity of organism.
- Neuron is the functional unit of nervous system.
- CNS consists of brain and spinal cord.
- PNS consists of cranial and spinal nerves.
- Activities performed consciously are called voluntary actions.
- Involuntary actions are not controlled consciously.
- Pathway of nerve impulse from receptor to effector is called reflex arc.
- Sudden involuntary responses are called reflex actions.

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. The basic unit of structure and function of nervous system is
   a. nerve. b. brain. c. neuron. d. spinal cord.
2. Which of the following is not part of forebrain?
   a. Cerebellum b. Cerebrum c. Thalamus d. Hypothalamus
3. Withdrawal of hand on touching hot object is an example of
   a. reflex action. b. reflex arc. c. voluntary action. d. conscious activity.
4. Everything you do is controlled by
   a. respiratory system. b. circulatory system.
   c. digestive system. d. nervous system.
5. Nervous system is made up of
   a. brain, spinal cord and heart. b. brain, spinal cord and blood vessels.
   c. nerves, arteries and veins. d. brain, spinal cord and nerves.
6. Neuron cell fibres which conduct nerve impulses toward cell body are
   a. axons. b. dendrites. c. myelin sheath. d. nerve.
7. Brain stem includes all EXCEPT
   a. medulla oblongata. b. midbrain. c. cerebellum. d. pons.

8. Which is the largest part of brain?
   a. Brain stem b. Hypothalamus c. Thalamus d. Cerebrum
9. Which part of the brain keeps you breathing?
   a. Cerebrum b. Thalamus c. Hypothalamus d. Medulla oblongata
10. Which part of the nervous system will help you to keep balance while riding a bicycle?
   a. Spinal cord b. Pons c. Cerebellum d. Cerebrum

B. Short questions:

i). Name three types of neurons and give their functions

ii). Which receptors and effectors are involved in the reflex actions of:
   (a) Blinking of eyes in light spark (b) Withdrawal of hand on touching hot object

iii). What is the significance of peripheral nervous system?

iv). Differentiate between receptors and effectors.

v). What is the significance of interneurons?

C. Long questions

1. Give the structure of human brain and roles of different parts of brain.
2. Differentiate between reflex arc and reflex action and explain the pathway followed by nerve impulse in a reflex arc.

D. Structured response questions:

1. Medulla oblongata, pons and midbrain collectively form brain stem.

a. Look at the functions controlled by these parts and suggest what will happen if brain stem dies?

_____

_____

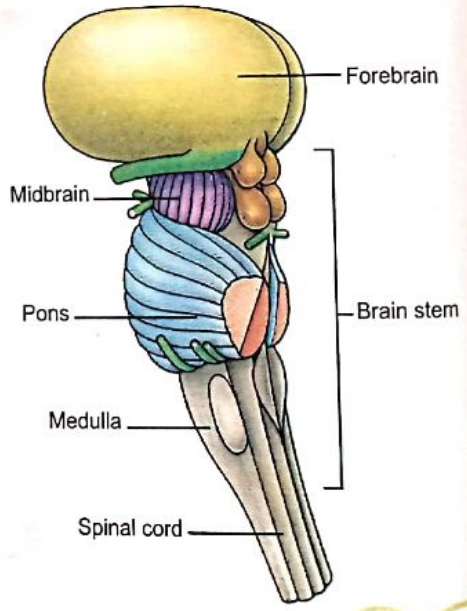
_____

b. What will happen if connection between cerebellum and brain stem is damaged in an accident?

_____

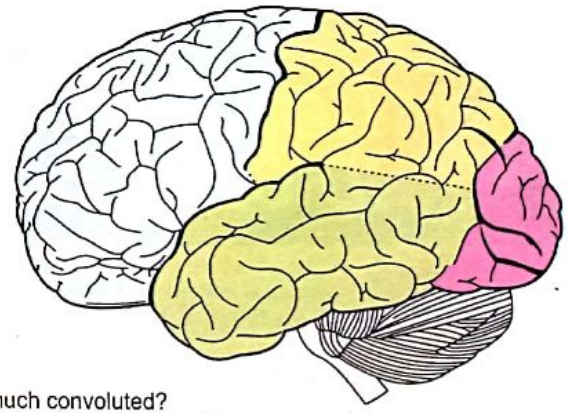
_____

_____



UNIT 2 HUMAN NERVOUS SYSTEM

2. Humans have largest cerebrum than any other animal.



a. Why is it so much convoluted?

_____

b. Give the advantages of having large cerebrum.

_____

c. Enlist the roles of cerebrum.

_____

E. Project work

With the help of play dough make a model of human nervous system showing brain, spinal cord and some nerves originating from brain and spinal cord.

UNIT 3

VARIATIONS, HEREDITY AND CELL DIVISION

Learning outcomes:

At the end of this unit, students will be able to:

- Describe variation and adaptation in living organisms.
- Explain and illustrate the differences between variation and adaptation.
- Identify sources of variation from environmental and genetic factors.
- Explain how different adaptations affect the chances of survivals of different species of organism.
- Recognize Genetics as the study of Heredity and understand and define heredity as the transfer of genetic information that specifies structure, characteristics, and functions, from parents to offspring.
- Differentiate between the concept of genes and chromosomes and relate them to how genetic characteristics are inherited.
- Describe the composition and structure of DNA.
- Design a model of DNA to demonstrate its structure, functions, and various components.
- Describe cell division and its types – mitosis and meiosis and relate them to the passage of genetic information through reproduction.
- Explain the process of mitosis and meiosis and identify their key phases.

3.1 GENETICS

Since thousands of years humans understood that certain physical characteristics could be transmitted from one generation to another. Traits such as eye colour, skin colour, height and hair texture are passed from parents to offspring. Each individual has some features identical to parents, grandparents or siblings. Genetics is a field of biology that studies how traits are passed from parents to their offspring. The passing of traits in next generation is known as heredity, therefore, genetics is the study of heredity.

Figure 3.1 Variation in Flowers

STOP AND CHECK

Have you ever had such a fascinating experience that a stranger had recognized whose child you are or whose sibling you are? How was he able to make such an accurate guess? Share your experience.

3.2 VARIATIONS

Two individuals produced sexually are never genetically identical. Variations are differences in traits between individual of the same species. Variations within a species are essential for the survival of species.

In sexually reproducing organisms genetic variations are caused by:

- Crossing over
- Mutations

Environmental factors which cause variations include:

- diet
- temperature
- humidity

Some variations have few distinct forms and are called discontinuous variations like free or attached ear lobes and blood groups. On the other hand the variations which have a wide range of types from one extreme to other are called continuos variations e.g. human height and skin colour.

Skin Colour Variations in Humans

Figure 3.2 Continuous Variations

Attached Earlobe

Free Earlobe

Figure 3.3 Discontinuous Variations

3.3 ADAPTATION

Adaptation is the process by which a species becomes fit to its environment. Individuals of a species may differ in many traits. Some may be larger, hairier, fight off infections better, or have smaller ears. Some of these traits provide competitive advantages like speed, strength, or attractiveness. More adaptive characters mean better survival rates. So well adapted organisms live longer, get chance to produce more offsprings and the species as a whole becomes successful.

Figure 3.4 Chameleon changes colour to adopt its environment

UNIT 3 VARIATIONS, HEREDITY AND CELL DIVISION

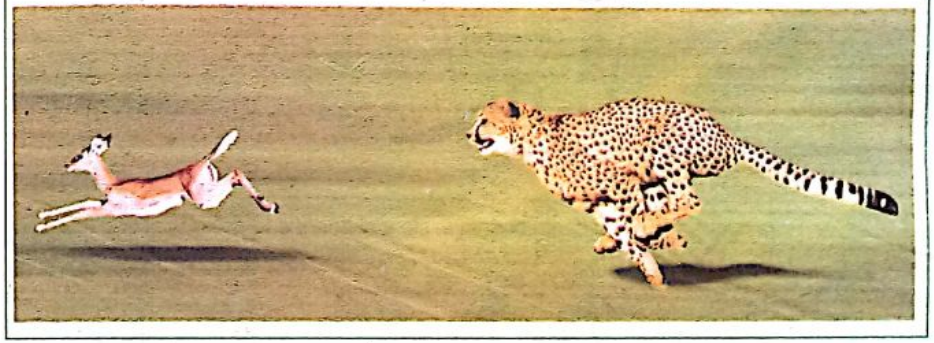
An adaptation can be structural, meaning it is a physical part of the organism. An adaptation can also be behavioral, affecting the way an organism responds to its environment

An example of a structural adaptation is the way some plants have adapted to life in dry, hot deserts. Such plants store water in their short, thick stems or leaves e.g. cactus.

Seasonal migration is an example of a behavioural adaptation. Many birds migrate from Siberia to Pakistan and some other countries to avoid extreme cold. Similarly many plants shed their leaves in winter to prevent water loss.

Try it yourself

Watch few videos of cheetah hunting on some other animal. Enlist structural adaptations which make cheetah a good predator.



3.4 CHROMOSOMES AND DNA

Life depends on the ability of cell to store and transfer its genetic information to the next generation. This ability of the cell resides in its nucleus as it has chromosomes. Each kind of organism has a specific number of chromosomes. The chromosomes occur in pairs. Humans have 46 chromosomes in all body cells. Chromosomes are made up of proteins and DNA. Proteins fold and pack DNA in the chromosome. DNA is responsible for the transmission of hereditary information from one generation to the next.

DNA on the chromosomes forms genes. Genes control traits of organisms like skin colour, height, blood groups in human. Chromosomes carry these genes to next generations when cells divide.

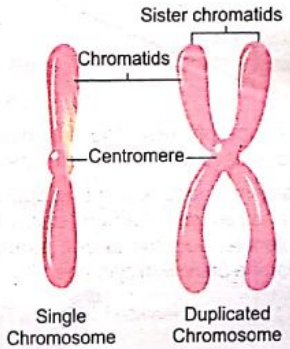


Figure 3.5 Chromosome

Chemical composition of DNA

DNA is the hereditary material of all the living organisms. It is made up of small units called nucleotides. Each nucleotide consists of three components. These are:

- a 5 carbon sugar called deoxyribose
- a nitrogen containing base
- a phosphate group

There are four types of nitrogenous bases:

- Adenine
- Guanine
- Cytosine
- Thymine

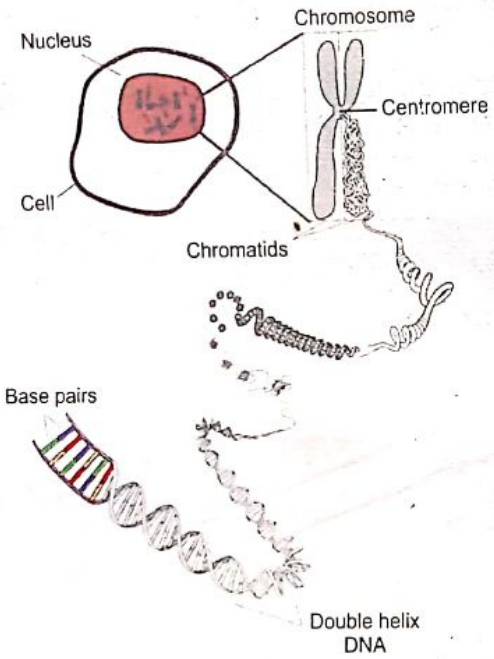


Figure 3.6 Chromosome and DNA in Cell

The type of nucleotide depends on the type of nitrogenous base. So there are four types of nucleotides which depend on the type of nitrogenous base.

Many nucleotides join in a specific order to form a polynucleotide strand. Two polynucleotide strands are coiled around each other in manner of a spiral ladder to form DNA molecule. In a DNA molecule, adenine in one strand forms a link with thymine in the opposite strand. Similarly, guanine pairs with cytosine.

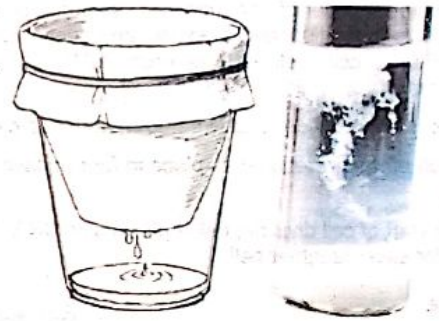
Figure 3.7 DNA a Spiral Ladder

UNIT 3 VARIATIONS, HEREDITY AND CELL DIVISION

Activity 3.1 DNA extraction

Materials required:

- One piece of some soft fruit (banana or strawberry)
- Water (30 ml)
- Chilled isopropyl alcohol (30 ml)
- Dish soap (2 drops)
- Table salt (1 pinch)
- Cloth filter
- Elastic band
- Two glass jars
- Spoon



Procedure:

(i) Put one inch piece of banana in a glass jar and mash it by using clean spoon.

(ii) Add 30 ml of water and a pinch of table salt. Continue to mash for another 2- 3 minutes.

(iii) Secure the cloth filter over the opening of other jar using an elastic band.

(iv) Pour the mashed fruit mixture through the filter.

(v) After filtration is complete, remove the filter and discard it. Keep the liquid part in jar.

(vi) Add two drops of dish soap to the liquid in jar and gently swirl the liquid without making bubbles.

(vii) Tilt the jar and slowly pour 30 ml of isopropyl alcohol so that it gently runs down and forms a layer over the top of fruit mixture.

(viii) Let the solution sit for few minutes.

(ix) You will see some white fluffy strands begin to appear at the boundary between fruit solution and alcohol. That is DNA.

3.5 CELL DIVISION

The life of each sexually produced organism starts from a single cell called zygote. The continuous process of cell division produces huge number of cells which change into different types to form tissues and organs of the organism. An adult human body has trillions of cells which are all produced from zygote by the process of cell division. Cell division has two types: mitosis and meiosis.

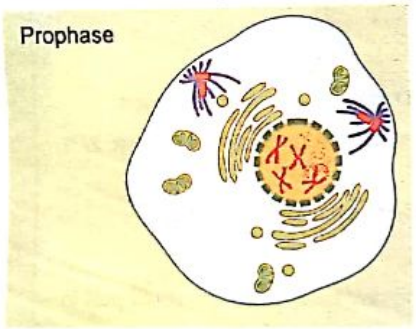
3.6 MITOSIS

In mitosis a parent cell divides to produce two identical daughter cells. Both daughter cells have the same number of chromosomes as in the parent cell. Growth, development, healing of wounds, regeneration and asexual reproduction take place through mitosis. Before the start of mitosis, cell replicates its entire DNA so as to produce an extra copy of each chromosome.

At first, the nucleus divides into two nuclei, and then cytokinesis takes place.

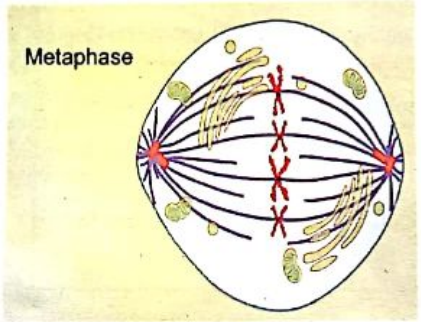
The division of the nucleus takes place in four phases: prophase, metaphase, anaphase and telophase.

Before the start of cell division, cell replicates its DNA. So cell contains two copies of its entire DNA one for each daughter cell.



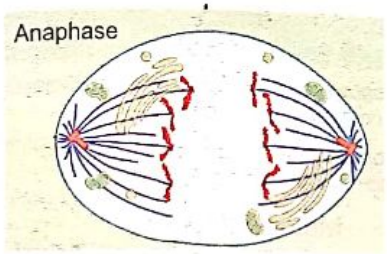
Prophase

DNA is coiled up tightly so chromosomes become visible. As DNA is already replicated, each chromosome has two chromatids attached at centromere.



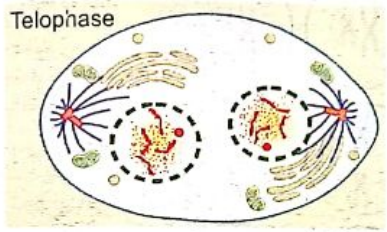
Metaphase

All chromosomes are aligned in the centre of the cell.



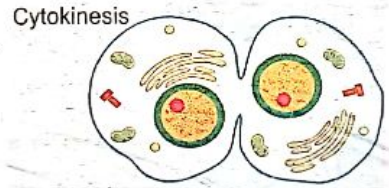
Anaphase

Each centromere splits. The separated chromatids move to their poles.



Telophase

Chromosomes uncoil and disappear.



Cytokinesis

Finally two daughter cells separate from each other.

3.7 MEIOSIS

Meiosis takes place to produce reproductive cells called gametes i.e. eggs and sperms. For sexually reproducing organisms zygote is formed by the fusion of a sperm with an egg. This means egg and sperm must have half the number of chromosomes as the normal body cell. Meiosis is a reduction division which reduces number of chromosomes to half in gametes. Moreover a process called crossing over helps to create variations in the next generations.

It involves two consecutive divisions; meiosis I and meiosis II. As a result four daughter cells are produced each having half the number of chromosomes as compared to parent cell.

Meiosis I

Prophase I: Chromosomes appear as thick threads due to tight coiling of DNA. As there are two chromosomes of each type, identical chromosomes pair with each other. These chromosomes

exchange segments. This process is called **crossing over** which results in variations in offspring.

Metaphase I: Pairs of chromosomes arrange themselves in the centre of the cell.

Anaphase I: Paired chromosomes separate and move to opposite poles. Each pole receives one member of all chromosomal pairs i.e. half chromosomes compared to parental cell.

Telophase I: Nuclear membrane is formed around the chromosomes at each pole. Thus two daughter cells with half chromosomes are formed each of which divides again by meiosis II.

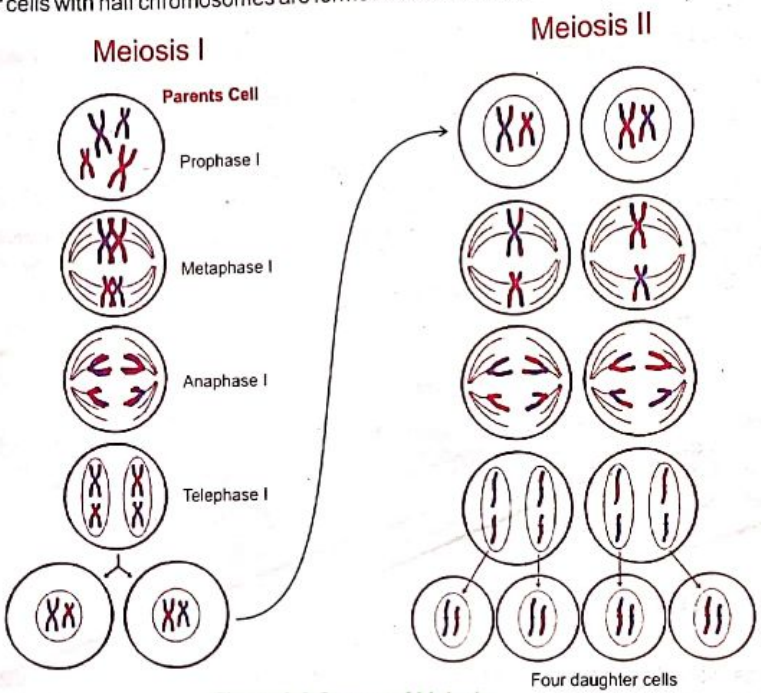


Figure 3.8 Stages of Meiosis

Meiosis II

Two daughter cells formed after meiosis I divide again. This process of meiosis II is just like mitosis.

Finally four daughter cells are produced each having half the number of chromosomes as compared to parent cell.

Teaching Point: Teacher should explain how human body is constructed from a single cell.

UNIT 3 VARIATIONS, HEREDITY AND CELL DIVISION

Activity 3.2 Variations in humans

Develop a questionnaire as given in the sample. Collect data of at least 20 persons.

Name: .....Age: ..... Gender: .....

Blood group (ABO system)	
Tongue rolling	
Skin colour	
Free or attached ear lobe	
Height	
Hair colour	
Left or right handed	
Foot size	
Pulse rate (at rest)	
Eye colour	

a. Which trait shows most variability?

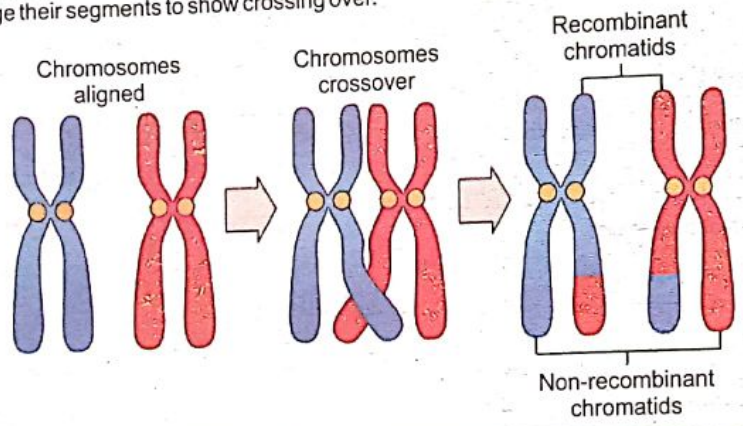
b. Based on your data separate these traits as continuous or discontinuous variation.

Continuous variations:

Discontinuous variations:

Activity 3.3 Crossing over

Make two identical chromosomes using paper and cutter. Colour both of them differently. Exchange their segments to show crossing over.



Key Points

- Genetics is the study of genes and their role in inheritance.
- Genes are units of inheritance. DNA is made up of units called nucleotides.
- Chromosomes carry genes.
- Variations are differences among the members of same species.
- Successful organisms are those which adapt to their environment.
- Mitosis retains the number of chromosomes in daughter cells.
- Meiosis is a reduction division which reduces number of chromosomes to half in gametes. It is necessary to maintain the number of chromosomes in next generation produced through sexual reproduction.

UNIT 3 VARIATIONS, HEREDITY AND CELL DIVISION

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. Which of the following is a continuous variation in humans?
   a. Tongue rolling b. ABO blood groups
   c. Intelligence d. Free or attached ear lobe
2. The chromosomes are chemically composed of
   a. DNA and carbohydrates. b. DNA and proteins.
   c. proteins and lipids. d. DNA and lipids.
3. The analysis of a DNA molecule shows 30% adenine nucleotide. The amount of guanine nucleotide in this molecule will be
   a. 10%. b. 20%. c. 30%. d. 40%.
4. Which of the following is not the component of a nucleotide?
   a. Gene b. Phosphate group c. Deoxyribose d. Nitrogenous base
5. Which of the following makes a difference of meiosis from mitosis?
   a. the appearance of chromosomes in prophase b. crossing over
   c. spindle formation d. cytokinesis
6. For each biological trait there is a:
   a. Nucleotide b. Chromosome c. Cell d. Gene
7. All of the following involve mitosis EXCEPT
   a. gamete formation. b. healing of wounds. c. growth. d. development.
8. In the constantly changing environment, the survival of species depends on
   a. less number of genes. b. small population size.
   c. more variations. d. more competition.
9. A gamete of pea plant has seven chromosomes. What will be the number of chromosomes in each cell of adult plant if it is diploid organism?
   a. 07 b. 14 c. 21 d. 28
10. The pairing of chromosomes takes place during
    a. prophase of mitosis. b. anaphase of mitosis.
    c. prophase I of meiosis. d. prophase II of meiosis.

B. Short questions

1. Why is meiosis important in organisms that reproduce sexually?
2. State the importance of mitosis in human life.
3. What is the significance of spindle fibres in cell division?
4. You never see frogs, snakes and lizards during extreme winter as they hibernate. What type of adaptation is it? Explain.

C. Long questions

1. What are variations? Give different causes of variations.
2. Describe the process of mitosis in detail.

D. Structured response questions

1. Look at the coloured spiral structure of DNA

i). Show units of DNA molecule in different colours.

Adenine _____ (colour)

Guanine _____ (colour)

Cytosine _____ (colour)

Thymine _____ (colour)

ii). Explain how these units pair to form DNA molecule.

_____

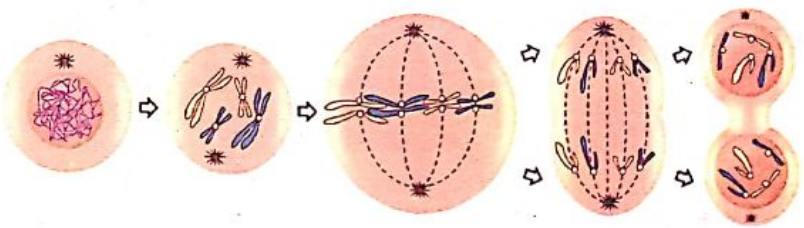
_____

_____

_____

2. Observe the stages of mitosis under the microscope through prepared permanent glass slides

Mitosis



Non-dividing Cell Prophase Metaphase Anaphase Telophase

i) Explain the difference in appearance of chromosomes at prophase and telophase stage.

_____

_____

_____

ii) Why chromosomes are not visible in non-dividing cell?

_____

_____

_____

E. Project work

Use wires and beads of different colour and construct a helical model of DNA molecule.

UNIT 4

BIOTECHNOLOGY

Learning outcomes:

At the end of this unit, students will be able to:

- Define biotechnology as the use of living cells and organisms in products and processes that can improve the quality of life
- Illustrate how biotechnology is a discipline/ field that has the potential to transform how we live
- Discuss the applications of biotechnology in the Pakistan context and their effects on the people and the environment of Pakistan over time. Illustrative examples (bread making, making of yogurt and cheese vaccines for immunization, insulin production, dyes etc.
- Relate the use of biotechnology in food sciences in producing foods with higher nutritional value and improved taste and quality (how fermentation has been improved by genetically modified organisms or the introduction of certain genes to raise iron content in rice, can be taken as example).

The application of modern techniques in fields like engineering and medicines is called technology. Biotechnology includes a broad range of technologies that employ living organisms or parts of them to make diverse products. For example, drugs, nutritional compounds, environment friendly chemicals and biofuels can be produced through biotechnology.

4.1 BIOTECHNOLOGY IN THE FIELD OF FOOD AND AGRICULTURE

The increasing human population needs higher yield of milk, meat, cereals, fruits, vegetables etc. Biotechnology has helped farmers to improve quality of their animals and crops in many aspects.

Genetically modified animals are producing more milk and meat.

DO YOU KNOW?

Genetically modified organisms (GMO) are plants, animals, bacteria, or viruses that have been genetically changed by scientists using DNA from another organism. GMOs are commonly used in food products.

Figure 4.1 Featherless GMO Chicken with more meat

Figure 4.2 Hornless GMO Bull with more meat

Figure 4.3 GMO Cow can produce human milk

Fruits and vegetables with better quality and improved shelf lives are also being produced on large scale.

Figure 4.4 GMO Strawberry stays fresh longer

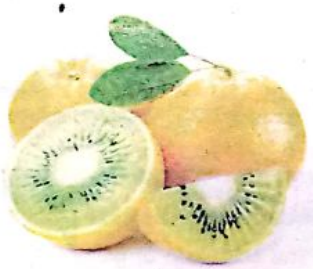


Figure 4.5 GMO Kiwi with Orange Peel

Figure 4.6 GMO Corn with more Yield

Figure 4.7 GMO Tomato with more Yield

Major staple crops are often deficient in some of the nutrients required in human diet. Thus, mineral deficiency diseases are widespread especially in poor populations across the globe. Iron deficiency anemia has severe consequences for human health, working ability, and quality of life. Rice is one of the most important staple foods for a large part of the world's population.

DO YOU KNOW?

In Pakistan institutes like PARC and NIAB are working on food crops for their better yield.

The process of increasing the density of vitamins and minerals in a crop is called biofortification.

Therefore, biotechnology approaches have targeted at increasing iron content in the rice grain. Biofortification of wheat includes new varieties of wheat with higher iron and zinc content in wheat grain.

Figure 4.8 Biofortified rice with more iron

Figure 4.9 Biofortified Golden Rice is produced to be grown and used in areas with a shortage of dietary vitamin A.

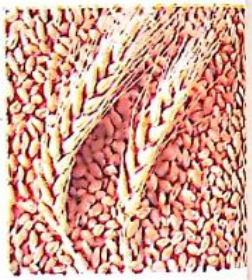


Figure 4.10 Biofortified wheat with more iron and Zinc

DO YOU KNOW?

The cultivation of genetically modified cotton and maize in Pakistan has significantly increased the yield of these crops.

UNIT 4 BIOTECHNOLOGY

As, obesity rates climb to epidemic levels, biotechnology is helping to create a new generation of healthier oils from soybeans, canola and sunflowers. These oils are free of such fats that can raise cholesterol and contribute to heart disease.

DO YOU KNOW?

A genetically modified sheep produces human clotting factor in her milk. This clotting factor helps persons suffering from haemophilia.

In some cases, biotechnology can improve a food by removing an allergen. Children with food allergies are particularly vulnerable to effects of allergens. Biotechnology scientists are working to isolate the specific proteins that trigger allergic reactions and modify the foods so as to eliminate the health risk.

4.2 FERMENTED FOODS

Can you list some fermented foods commonly used at homes? Although biotechnology is a new discipline, human began using microorganisms as early as 4000 BC for making vinegar, cheese, yogurt etc. Preparation of traditional fermented foods is more complex and time consuming. With the rapid progress in the biological sciences it has been possible to gain a better understanding of the way microorganisms perform fermentation processes. The types of microorganisms involved has been isolated and identified, and the physiology and metabolism of these organisms have been studied. Hence, traditional fermented foods can now be made better, faster, and more economical.

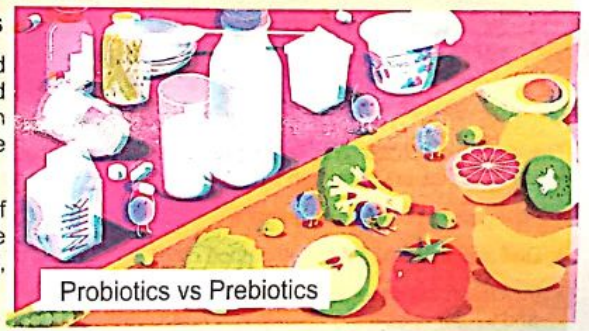
Fermented foods can be obtained from milk (Yogurt, cheese, kefir), Fruits (vinegar, cider), vegetables (pickles, kimchi), legumes (soy sauce) and meat (sausage, pepperoni, salami)

INTERESTING FACTS

Probiotics and Prebiotics

Probiotics are made up of good bacteria that live in your gut and help you to improve your health and wellness. Probiotics are found in fermented foods.

Prebiotics help in the growth of probiotics in your digestive system. e.g., tomatoes, onion, garlic, bananas, beans etc.



Probiotics vs Prebiotics

The targeted alteration of genetic material of the yeast and bacteria used in fermentation has improved their fermentative qualities. Modern baking process takes advantage of improved cereal grains and use of specific enzymes from yeast.

Biotechnology is useful in the isolation and production of enzymes used directly in food processing. For example the enzyme amylase affects the texture and freshness of bread dough.

Figure 4.11 Fermentation in Baking

GMO yogurt is produced by GM Lactic acid bacteria. These bacteria are very beneficial for the health of the digestive system. Many lifelong digestive diseases can be easily treated by consuming this yogurt daily.

GMO cheese is produced by using an enzyme chymosin required as a clotting agent. This enzyme was traditionally obtained from the fourth stomach lining of young calves.

Figure 4.12 Fermented Cheese

Figure 4.13 Fermented Yogurt

The ways biotechnology is helping to solve food related issues of human include:

- Fast growing plants and animals.
- Disease and drought resistant food crops.
- Increased supply of food with reduced cost and longer shelf life.
- Most nutritious food.
- Tastier food.

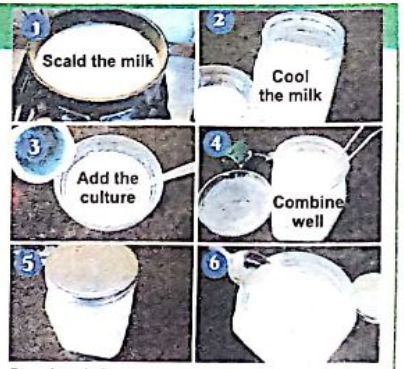
DO YOU KNOW?

Food companies in Pakistan are using biotechnology on commercial scale for the production of yogurt, cheese, pickles etc. and marketing them throughout the country.

UNIT 4 BIOTECHNOLOGY

Activity 4.1 Making of yogurt

- Take two cups of milk in a pot and boil it for half an hour to sterilize it.
- Let it cool to room temperature.
- Add a spoon of yogurt in the milk
- Mix it well.
- Cover the pot with a towel and incubate it until it sets.
- Open it after incubation and see the result.



a. Why you boiled milk at the start?

b. Why you allowed boiled milk to cool to room temperature?

c. Why you added a spoon of existing yogurt in the milk?

d. What change you observed after incubation period?

e. What factor caused this change?

Teaching Point: While making yogurt at home, teacher will explain the sources of microorganisms which convert milk to yogurt.

4.3 BIOTECHNOLOGY IN MEDICINE

Do you know someone who has diabetes? Have you heard that many diabetes patients need insulin injection daily? Insulin is a hormone deficient in diabetes patients. Earlier it was very difficult to obtain insulin from the blood of many slaughtered animals. In 1982, a human version of insulin became available to control blood glucose level. This insulin was produced by inserting human insulin gene in bacteria. This drug is still saving lives today, and the next few years may bring inhaled forms of insulin.

Other hormones being produced through this process include human growth hormone and thymosin which can be useful in treating brain cancer.

Vaccination is considered to be the most effective method for disease prevention and control. Hepatitis B and COVID-19 vaccines are produced using biotechnology methods.

DO YOU KNOW?

In 1982 insulin became the first ever biotechnology medicine to be commercialized.

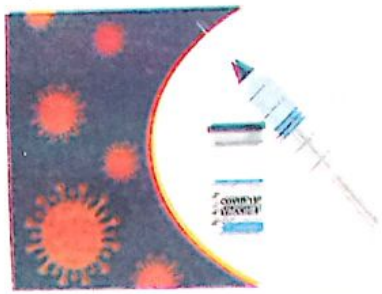


Figure 4.14 Covid-19 Vaccine

Figure 4.15 Insulin Hormone

The ways biotechnology will help to improve human health issues include:

- diagnosis of diseases in short time
- development of appropriate medicines
- more accurate methods of determining correct drug dosages
- improvements in the drug discovery
- better vaccines
- gene therapy.

DO YOU KNOW?

Many medicine companies in Pakistan are producing insulin and other medicines through biotechnological process.

4.4 APPLICATIONS OF BIOTECHNOLOGY

Scientists have found the ways to use biotechnology which will ultimately change the way we live. Biotechnology is already contributing to solve issues related to food, agriculture, medicines and environment. Here are some achievements of biotechnology:

- Foods produced by the use of microorganisms are more nutritious as they contain essential nutrients like vitamins and minerals.
- Foods produced by fermentation process have better taste and quality and have longer storage life.
- More yields of milk, eggs and meat have become possible by using modern techniques.
- Crops resistant to disease and harmful insects are being cultivated in most part of the world. It is helping to solve the food shortage problem of increasing human population.
- Many vaccines are in use to prevent infections.
- Human hormones like insulin and human growth hormone are produced by genetically modified microorganisms.
- Fuels like biodiesel and ethanol are helping to reduce the use of fossils fuels.
- To avoid toxic chemicals, microorganisms are now being used to produce textile dyes.
- Biodegradable plastics are decomposed by bacteria and fungi. So these plastics do not cause pollution.
- Modified microorganisms are more efficient in removing wastes from the environment.
- Some microorganisms are in use to remove toxic wastes from the environment.

Figure 4.16 Biodegradable Plastic

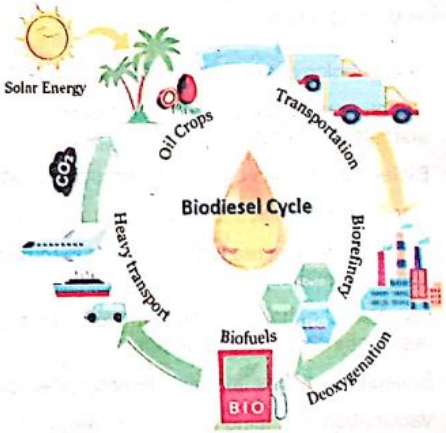


Figure 4.17 Bio Fuel

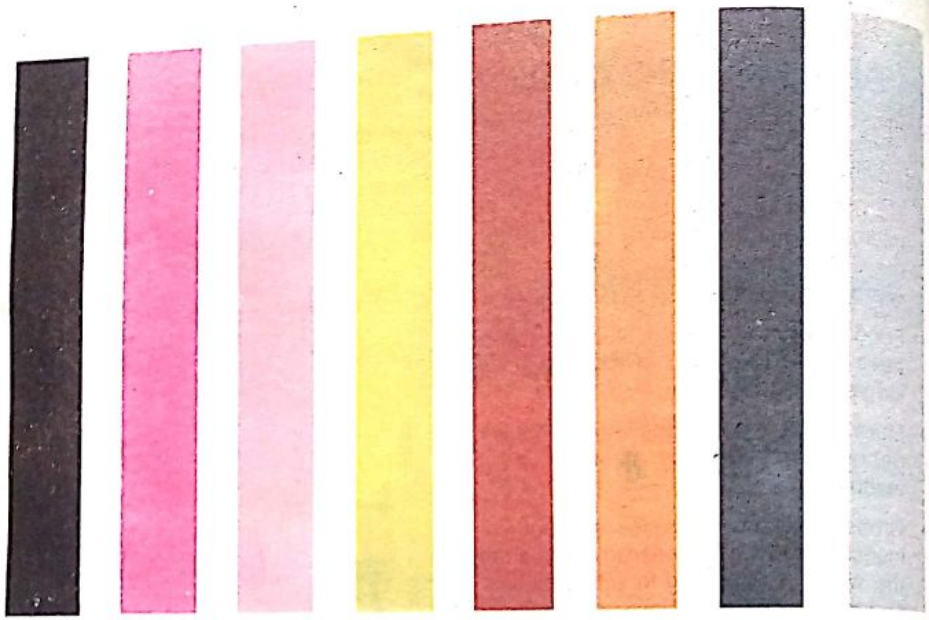


Figure 4.18 Dyes produced by GMO Bacteria

Key Points

- Biotechnology uses engineered living organisms to produce valuable products.
- Genetic engineering made it possible to modify not only microorganisms but also higher animals and plants.
- Biotechnology has enabled scientists to produce disease and drought resistant plants.
- Genetically modified animals are producing more milk and meat.
- Less cost and increased shelf life of food materials are ensuring food security to increasing human population.
- Insertion of genes in plants to absorb and store more minerals is helping to combat mineral deficiency diseases like anaemia.
- Biotechnology has improved health system helping fast diagnosis and personal drugs.
- Vaccination is helping to eradicate diseases.
- Biofuels are helping to control pollution and reduce the effect of global warming.
- Biologically produced dyes are replacing toxic synthetic dyes.

UNIT 4 BIOTECHNOLOGY

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. The most effective method to prevent a disease is
   a. surgery. b. organ transplant.
   c. vaccination. d. radiotherapy.
2. If a nitrogen fixing gene from cyanobacteria is successfully inserted in plant root cells
   a. plant roots will fail to grow. b. plant roots will fix nitrogen.
   c. plant roots will develop cyanobacteria inside. d. plant roots will kill cyanobacteria.
3. A genetically modified rice variety with more iron content will help to treat
   a. anaemia. b. night blindness. c. rickets. d. colour blindness.
4. Deficiency of insulin in human causes
   a. diabetes. b. heart disease. c. hypertension. d. epilepsy.
5. Which of the following can be used as a biofuel?
   a. Kerosene oil b. High octane c. Methane d. Ethanol
6. Which of the following is not a product of biotechnology?
   a. Polythene b. Insulin
   c. Human growth hormone d. Thymosin
7. Baking process uses enzymes from
   a. wheat. b. rice. c. corn. d. yeast.
8. A gene from one organism can be inserted into other one by
   a. tissue culture. b. cloning. c. genetic engineering. d. hybridization.
9. What could be the advantage of using microorganisms like bacteria to get useful products by genetic engineering?
   a. Bacteria grow at very fast rate b. Bacteria cannot be seen with naked eye
   c. Bacteria cause infections d. Bacteria die very soon
10. The best solution to hereditary diseases is
    a. vaccination. b. immunization. c. chemotherapy. d. gene therapy.

B. Short questions:

i). What could be the advantages of microbes produced dyes over synthetic dyes?

ii). Give the advantages of using biodegradable plastic.

iii). What is the significance of fermented food?

iv). How biotechnology can transform the way of treating diseases?

v). What could be the best solution to mineral deficiency diseases in third world countries?

C. Long questions:

1. Explain how biotechnology is helping to solve issues of food shortage?
2. What are the applications of biotechnology?

D. Structured response questions:

1. Think like a biotechnologist.

Plastic pollution is a severe threat to land and water bodies. Recently a very efficient plastic eating mushroom is discovered in Amazon forest. This mushroom can be grown on landfills to breakdown plastics. But mushrooms cannot grow in water (river, ocean etc.) How this mushroom can be used to solve plastic pollution in water bodies. Brainstorm and predict steps that can be used to reach the solution.

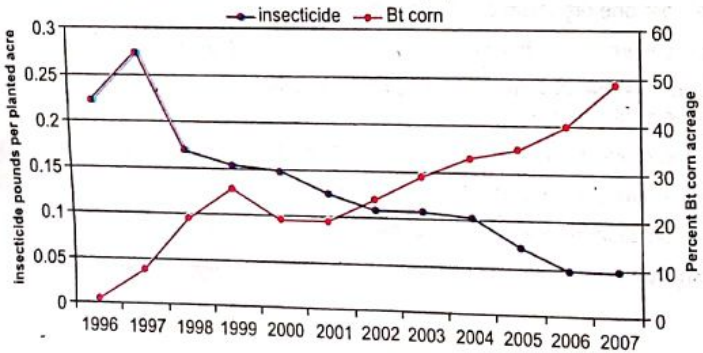
Step 1 is done for you.

Step 1: Identify mushroom genes responsible for plastic breakdown

Step 2:

2. Graph shows use of insecticides and cultivation of genetically modified (GM) corn.

Look at the changing trend and answer the following questions:



UNIT 4 BIOTECHNOLOGY

a. What type of gene has been inserted in this corn?

b. Why the use of insecticides has decreased progressively?

c. Why farmers preferred genetically modified corn over normal verities?

d. Give the environmental advantage of cultivation of this corn.

3. In 1796, Edward Jenner inoculated a boy with cowpox virus which is considered the first ever vaccination in human history. Cowpox material developed immunity in that boy against small pox.

a. Why cowpox material provided immunity against small pox?

b. What is the present status of small pox?

c. Why vaccines are considered better solution against infectious diseases?

d. Name diseases against which you have been vaccinated.

E. Project work

Make a chart showing colourful biodegradable objects with a message "Save the Environment".

Rf Db Sg Bh Hs Mt Ds Rg Cn Nh Fl Mc Lv Ts Og

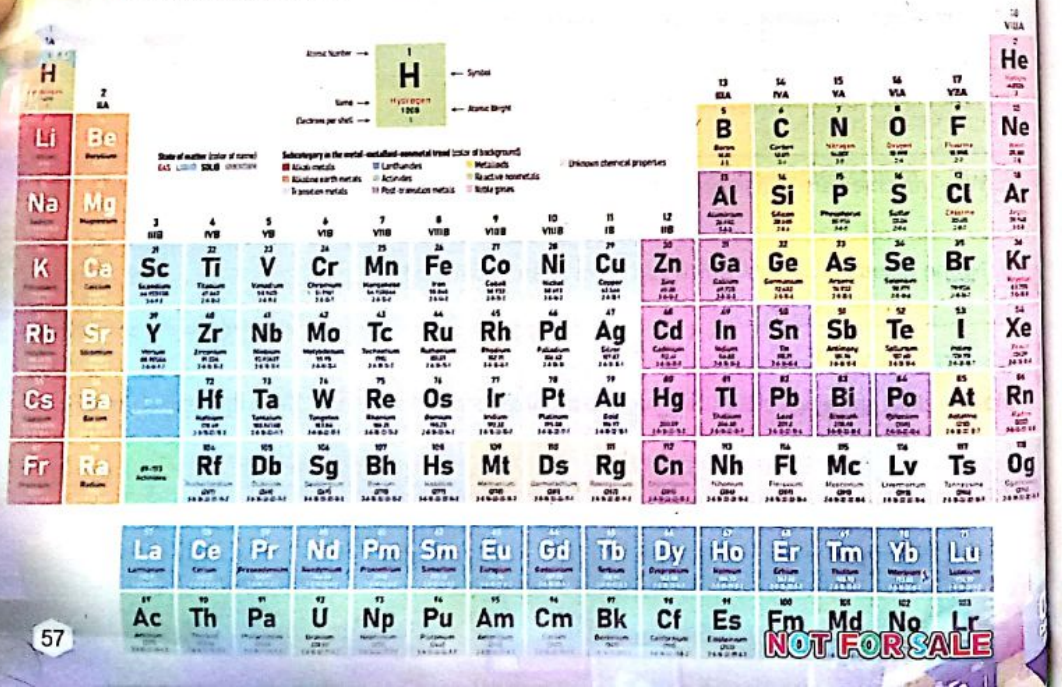
UNIT 5

THE PERIODIC TABLE

Learning outcomes:

At the end of this unit, students will be able to:

- Recognize Periodic Table as a way of classifying the elements in groups and periods.
- Identify the names and location of the first 18 elements only.
- Identify properties of metals and non-metals.
- Relate the properties to the uses of metals.



Recall that the atomic number of an element is the number of protons in the nucleus of atom of an element. Each element has a different atomic number. The elements also have different number of electrons. These electrons are arranged in energy levels called shells. Electrons present in the outermost shell are called valence electrons. These electrons take part in chemical reactions. Therefore, these electrons determine the chemical properties of elements. This knowledge will help you in understanding arrangement of elements in the periodic table.

DO YOU KNOW?

Element nobelium (atomic number 102) was discovered by Alfred Nobel who founded the Nobel Peace Prize.

5.1 INTRODUCTION

There are 118 elements. They combine to form millions of compounds. It is impossible to remember all the information about these elements and their compounds. So we clearly need some way to organize our knowledge about them.

If you have a large number of books in your study room and place them in a haphazard way, it will be very difficult to find the book you need. However, if these books are arranged into groups according to some common features, it would become easier to find the book you are looking for.

After the discovery of atomic number by Moseley in 1913, scientists noted that atomic number can be used to arrange elements in a systematic way. Thus elements were arranged in the order of increasing atomic numbers. A table showing the systematic arrangement of elements is called Periodic Table.

DO YOU KNOW?

The periodic table is widely used in chemistry, physics and other sciences. It is generally seen as an icon of chemistry. Periodic table shows the organized array of all the elements in order of increasing atomic numbers.

5.2 PERIODS

The most commonly used form of the periodic table is shown in figure 5.1. What do you observe in it?

The Periodic Table of Elements

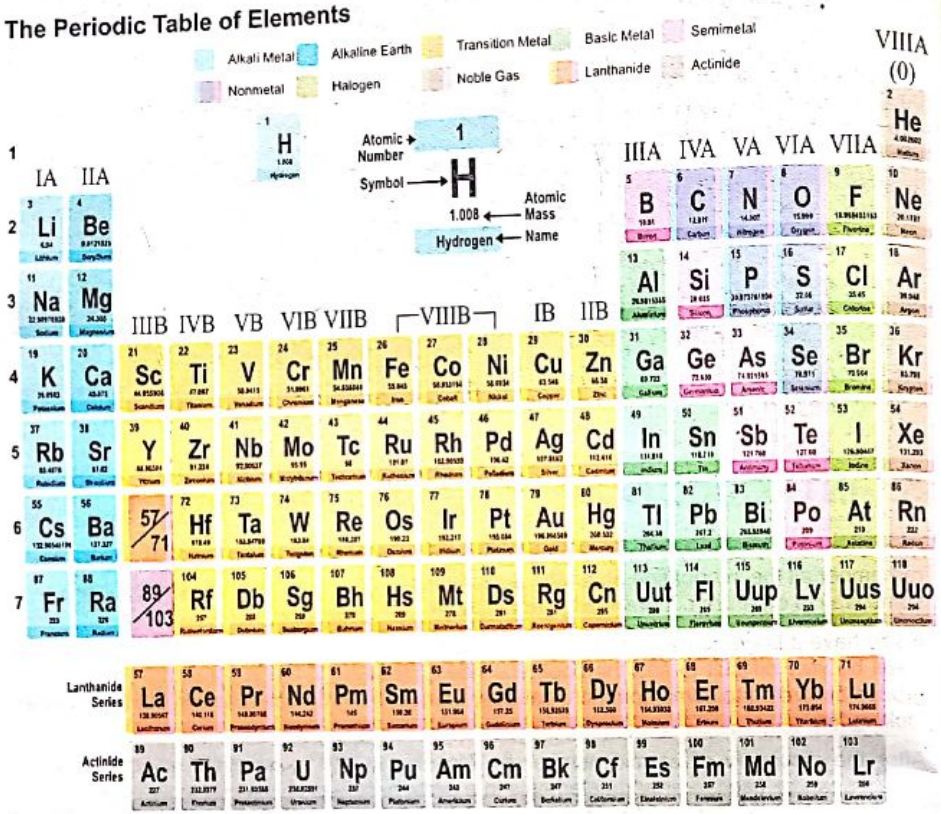


Figure 5.1 Periodic Table

In the periodic table the elements have been listed in order of increasing atomic numbers, from left to right and from top to bottom.

Note that hydrogen (H), atomic number 1, is at the top. Helium (He), atomic number 2, is at the top right corner. Lithium (Li), atomic number 3, is at the left end of second row. The horizontal rows in the periodic table are called periods. The period number shows the number of electronic shells in an element. Elements in the first period have one electronic shell filled with electrons. Second period shows two electronic shells and so on.

The number of elements in these periods range from 2 to 32.

STOP AND CHECK

How many periods do you find in the period table?

UNIT 5 THE PERIODIC TABLE

Activity 5.1 Elements in periodic table

Look at the periodic table and complete the missing data in the following table:

Period No.	No of elements
First	
Second	
Third	8
Fourth	
Fifth	18
Sixth	

Teaching Point: Teacher may help students to count elements in the periods.

5.3 GROUPS AND CLASSIFICATION OF ELEMENTS INTO GROUPS

Groups and classification of elements in groups

Each column in the periodic table of elements is called a group. Elements present in a group have same number of valence electrons. There are 18 groups in the periodic table. These are further divided in two groups A and B.

Group A elements are called main group elements. Group B elements are called transition elements. You need to recognize only first 18 elements, which are present in Group A.

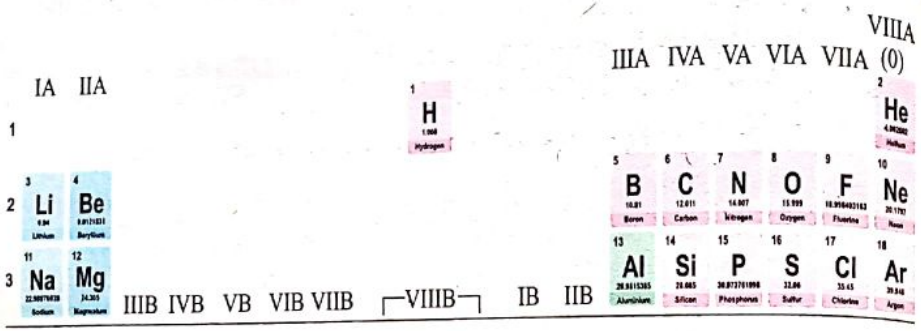


Figure 5.2 Location of first 18 elements

Common names for groups of elements:

Group IA - the Alkali metals

Group IIA - the Alkaline Earth metals

Group VIIA - the Halogens

Group 0 or VIIIA - the Noble gases

DO YOU KNOW?

The alkali metals are very reactive. They react rapidly with air and moisture. So, they are kept under oil. They are soft and can be cut with a knife.

INTERESTING FACTS

Early chemist gave the name "earths" to alkaline earth metals. This is because they are found both in the earth curst and in sea water.

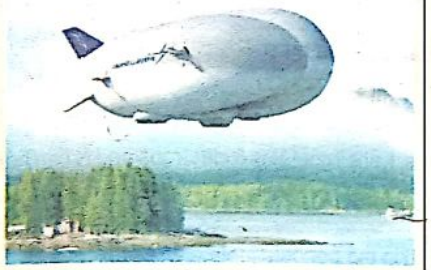
DO YOU KNOW?

Noble gases exhibit great stability and extremely low reaction rates.

UNIT 5 THE PERIODIC TABLE

DO YOU KNOW?

Air ships are filled with helium, since it is very light and unreactive.



Neon gives out light when high voltage electricity is passed through it, so it is used in glowing neon advertising signs.

Activity 5.2: Electronic configuration

Draw the electronic structure of following elements present in Group IA:

- Lithium, Li (atomic number 3)
- Sodium, Na (atomic number 11)
- Potassium, K (atomic number 19)
- How many electrons, these elements, contain in their outermost shell?

Solution:

- Electron distribution in these elements is:
- Li = 2, 1
- Na = 2, 8, 1
- K = 2, 8, 8, 1
- In Group IA all the elements have one electron in their outermost shells.

Draw the electronic structures of the following elements present in Group IIA:

- Beryllium, Be (atomic number 4)
- Magnesium, Mg (atomic number 12)
- Calcium, Ca (atomic number 20)
- How many electrons, these elements, contain in their outermost shell?

Solution:

- Electron distribution in these elements is:
- Be = 2, 2
- Mg = 2, 8, 2
- Ca = 2, 8, 8, 2
- In Group IIA all the elements have 2 electrons in their outermost shells.

Location of Elements in the Periodic Table:

- Location of an element in the periodic table largely depends on its electrons.
- The total number of valence shell electrons determine its group and the number of valence shell in which electrons lie determines the period number.

Steps:

1. Write distribution of electrons in shells.
2. Note the n value of the valence shell, this indicates period number.
   n=1 for K shell, n=2 for L shell, n=3 for M shell
3. Count total number of electrons in the valence shell. This indicates group number.
4. Remember K shell contains maximum 2 electrons, L shell contains 8 electrons and N can hold maximum 18 electrons.

Example 5.1

Identifying the location of carbon (atomic number 6) in the periodic table.

Solutions:

Electron distribution in carbon

C=2,4

1. Valence shell is L, its n value is 2, so carbon is present in second period.
2. Total number of valence electrons = 4 so its group is IVA in the periodic table.

Example 5.2

Identifying the location of magnesium (atomic number 12) in the periodic table.

Solution:

1. Electron distribution in magnesium is:

Mg = 2,8,2

2. As valence shell is M, n = 3. So, Mg is present in the third period.
3. Total number of valence electrons is 2, so Mg belongs to IIA in the periodic table.

Example 5.3

Identifying the location of Chlorine (atomic number 17) in the periodic table.

Solution:

1. Electron distribution in Chlorine is:
   Cl= 2,8,7
1. As valence shell is M, n = 3. So, Cl is present in the third period.
2. Total number of valence electrons is 7, so Cl belongs to VIIA in the periodic table.

UNIT 5 THE PERIODIC TABLE

Teaching Point: Teacher may give more examples to make a clear concept about location of elements in the periodic table.

5.4 METALS AND NON-METALS

The elements can be classified in three categories on the basis of their properties:

1. Metals
2. Non-metals
3. Metalloids

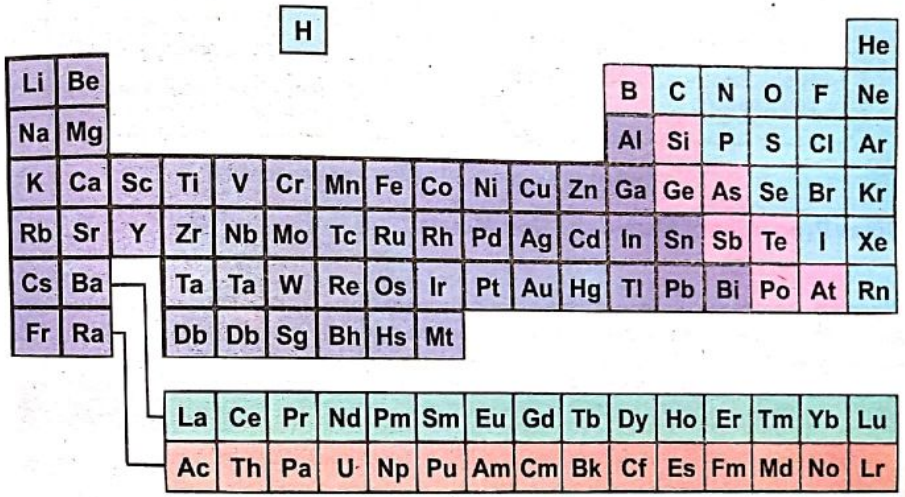


Figure 5.3 Position of Metals and Non-metals in the Periodic Table.

- Metals appear on the left hand side of the periodic table. (shown by dark blue colour)
- Non-metals are present on the right hand side of the periodic table.(shown by sky blue colour)

Examples of metals: Copper, Silver, Gold, Aluminium, Iron etc.

Examples of non-metals: Carbon, Sulphur, Hydrogen, Oxygen, Nitrogen etc.

Examples of metalloids: Boron, Silicon, Germanium etc.

Teaching Point: Most of the non- metals exist in gaseous state.

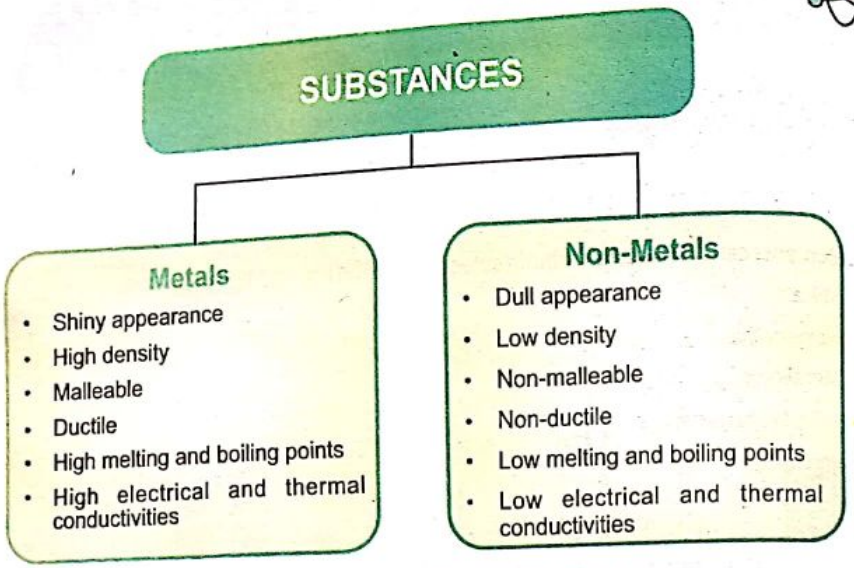


Figure 5.4 Shows physical properties of metals and non-metals.

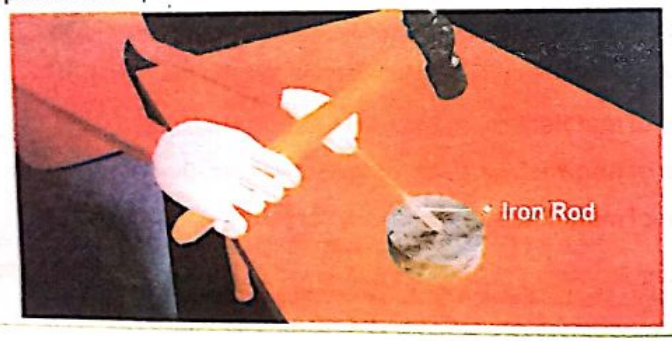
Some Properties of Metals and Non-Metals

1. Malleability:

When you beat a metal piece, it flattens and becomes thinner. This is because metals are malleable. When you beat a non-metal piece, it breaks down into smaller pieces. So non-metals are non-malleable.

Activity 5.3 Malleability of metals and non-metals

- Beat a thick piece of iron, copper and aluminium many times with a hammer.
- Beat a thick piece of coke (carbon) and sulphur.
- What happens to these pieces



UNIT 5 THE PERIODIC TABLE

2. Flexibility:

You can bend metals wires into different shapes without breaking. This is because metals are flexible. But non-metals do not bend, so they are non-flexible.

Activity 5.4 Flexibility of metals and non-metals

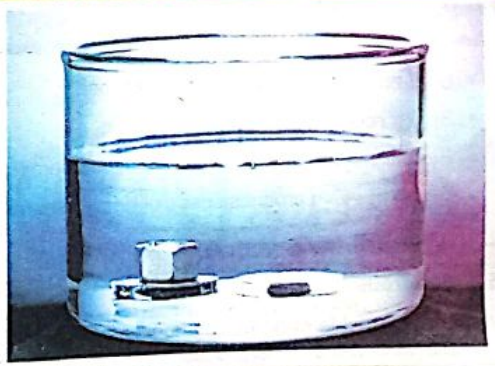
- Bend copper, iron and aluminium wires into different shapes.
- Try to bend graphite (carbon) rod.
- Are you able to bend them easily? Do they break when they are bend?

3. Density:

When you place metals in water, they sink in water. Most metals are denser than water. For this reason they sink in water. The density of a substance is its mass per unit volume. The density of copper is 8.96g per cm^3. Whereas the density of water is 1g per cm^3. Metals have higher density than water. Most of the non-metals are gases at room temperature. Non-metals have lower density.

Activity 5.5 Density of metals and non-metals

- Take small bar or nut or sheet of metals such as copper, iron and aluminium.
- Place one after the other, each bar or nut or sheet on the surface of water in a trough.
- What do you observe?
- Which do you think is heavier, water or metals?



4.Thermal Conductivity:

The ability of a material to allow heat to pass through it is called thermal conductivity. Metals have high thermal conductivity. Wood is non-metal, it does not allow heat to pass through easily so wood has low thermal conductivity.

Activity 5.6 Thermal conductivity of metals and non-metals

- Place a metal spoon and a wood spoon in a bowl of hot soup.
- Which spoon becomes hot more quickly?
- Which spoon would you use to eat a bowl of soup? Why?

5. Electrical Conductivity:

The ability of a material to allow electricity to pass through it is called electrical conductivity. Metals have high electrical conductivity. In metals, valence electrons are loosely held with their nuclei. When electricity is passed through them, then electrons begin to flow. So, metals conduct electricity from one end to the other. Copper is a good conductor of electricity. It is therefore used to make electrical wires.

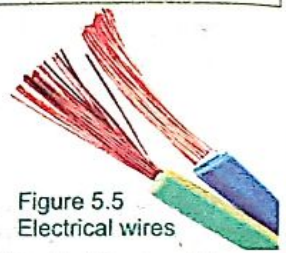
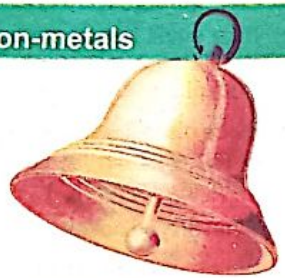


Figure 5.5
Electrical wires

Why electrical cables are covered with plastic? Plastic does not allow electric current to pass through it. Such a material is called electrical insulator. Plastic is made of non-metals, Non-metals are poor conductors of electricity except graphite (a form of carbon). In non-metals, valence electrons are strongly held with their nuclei. So, electricity cannot make them move across the non-metals.

Activity 5.7 Sonorous nature of metals and non-metals

- Beat an aluminium plate with a hammer.
- Beat a copper plate with a hammer.
- Beat plastic or wooden plate with a hammer.
- Which of these produces deep or ringing sound?



5. Sonorous:

Metals are capable of producing ringing sound. So, metals are sonorous, whereas carbon or phosphorus or wood do not produce ringing sound. Hence non-metals are non-sonorous.

UNIT 5 THE PERIODIC TABLE

5.5 USES OF METALS

Look around you. You can see many materials. What are materials made of? Materials are chosen on the basis of their physical properties. Physical properties of metals make it suitable for making many objects or its parts.

Different metals are used for different purposes.

- Most metals are not very hard or strong. We can make them harder and stronger. For this purpose metals are mixed with small amounts of other metals or non-metals (such as carbon) to form alloys. For example steel is an alloy of iron containing small amount of carbon and other metals. Brass is an alloy of copper and zinc. Bronze is an alloy of copper and tin.
- Many pots and pans are made of steel instead of pure iron. Why?
- Steel is a good thermal conductor and has shiny appearance. It has higher melting point and do not corrode easily by acids present in food. So, steel is used to make kettles and frying pans to withstand high temperature during cooking.

Figure 5.6 Steel pots

- Gold and Silver are shiny, ductile and malleable metals. Gold and silver are soft and can be shaped into rings, bangles and neckless easily. Their shiny appearance makes jewellery very attractive. So, gold and silver are used to make jewellery. Mixing gold with small amounts of silver and copper can produce different coloured shades in jewellery.

Figure 5.7 Gold Jewelry

- Aluminium is malleable, light and strong metal. It is used to make bicycle frames and rims. Alloys of aluminium with magnesium and zirconium can withstand high temperatures, are highly corrosion resistant, posses high strength used to make aeroplanes, solar panels and other aerospace technologies.

Figure 5.8 Uses of Aluminum

- Iron is used in construction of bridges and buildings because, it can resist high load stress and strain. So it is capable of lifting weight of different things at one time.

Figure 5.9 Use of Iron in construction

Key Points

- The elements in the Periodic Table are arranged in order of increasing atomic number.
- The vertical columns in the Periodic Table are called groups.
- The horizontal rows in the Periodic Table are called periods.
- Group number in the Periodic Table represents the number of electrons in the outermost shell.
- The outermost electrons are involved in chemical reactions.
- The elements having same number of electrons in their outermost shell, possess similar chemical properties.
- Metals are shiny, ductile, malleable, good conductor of heat and electricity and possess high melting points.
- Non-metals have dull appearance, non-ductile, non-malleable, bad conductor of heat and electricity and possess low melting and boiling points.
- Most metals are not very hard. We can make them harder and stronger by mixing with small amount of other metals or non-metals.
- Most of the non-metals exist in gaseous state.

UNIT 5 THE PERIODIC TABLE

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. Which of the following group contains alkali metals?
   a. IA b. IIA c. IIIA d. IVB
2. Which of the following elements is not an alkali metal?
   a. Li b. Na c. K d. Mg
3. An element has three electrons in its outermost shell. In which group of the Periodic Table it is likely to be found?
   a. Group IA b. Group IIA c. Group IIIA d. Group 0
4. Which of the following elements is a metalloid?
   a. Gold b. Sulphur c. Iron d. Silicon
5. Lithium is in the same group as
   a. magnesium. b. sodium. c. calcium. d. carbon.
6. Which of the following is a halogen?
   a. Magnesium b. Sodium c. Helium d. Fluorine
7. How many elements are present in the first period?
   a. 2 b. 8 c. 18 d. 32
8. How many electrons are present in the outermost shell in Group IIIA elements?
   a. 1 b. 2 c. 3 d. 8
9. Which of the following group contains noble gases?
   a. IA b. IIA c. VIIA d. 0
10. Period number of neon (atomic number 10) is:
    a. 1 b. 2 c. 3 d. 4

B. Short questions

i) Write common names for group of normal elements.

ii) Suggest why copper and aluminum are used in electricity cables.

iii) Many pots and pans are made of steel instead of pure iron. Why?

iv) Write three properties that make gold suitable for making jewellery.

v) In which portion of the periodic table are present

a. Metals

b. Non-metals

vi) Metals wires can be transformed into different shapes without breaking. Why?

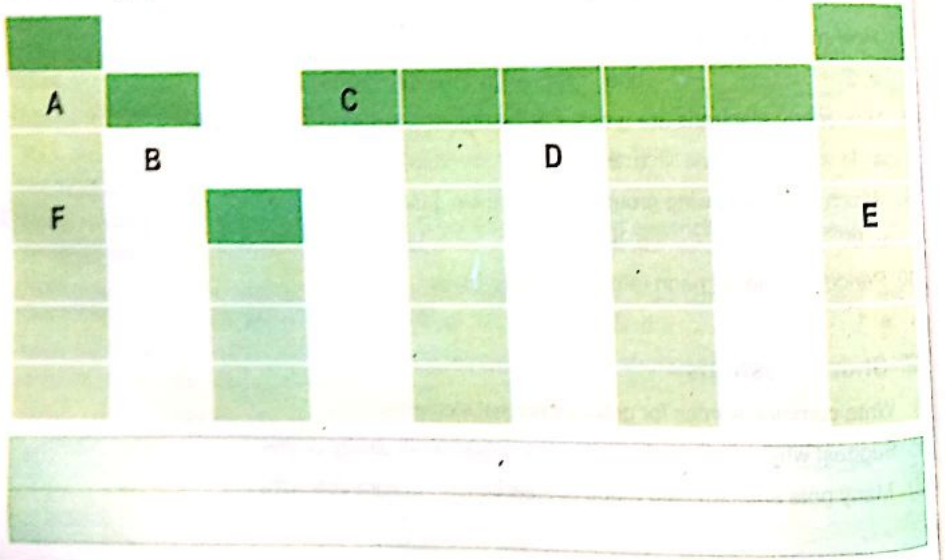
vii) Why electrical cables are covered with plastics?

C. Long questions

1. How can you locate an element in the periodic table? Identify the location of following elements in the Periodic Table?
   a) Aluminium (Atomic number 13)
   b) Silicon (Atomic number 14)
   c) Fluorine (Atomic number 9)
2. Justify that properties of metals make it suitable for making many objects or its parts. Explain with three examples.

D. Structured response questions:

1. Following figure shows some elements in the Periodic Table



UNIT 5 THE PERIODIC TABLE

a) Which elements are present in the same group?
b) Which elements are present in the same period?
c) What is the group number of C?
d) Which elements have same number of electrons in their outermost shell?
e) Which element is a noble gas?
f) Which element is alkaline earth metal?
g) In which group element E is present?
h) Which element has two electrons in its outermost shell?

2. Element carbon (At. No. 6) is present in Group IV A in the periodic table.
   a) Why is carbon placed in Group IV A in the periodic table?
   b) How many electrons carbon needs to complete its valence shell?
   c) How many single bonds carbon can make?
3. Draw electronic structures of:
   a) Oxygen (At. No. 8)
   b) Fluorine (At. No. 9)
   c) Neon (At. No. 10)
   Write the difference in the electronic structures of these elements.

E. Project work

1. Make an out line of the periodic table on a chart paper. Show the following elements on i some metals with brown colour, halogens with yellow colour, noble gases with red colour an some non-metals with blue colour
2. Search and write the commercial uses of noble gases and alkali metals.

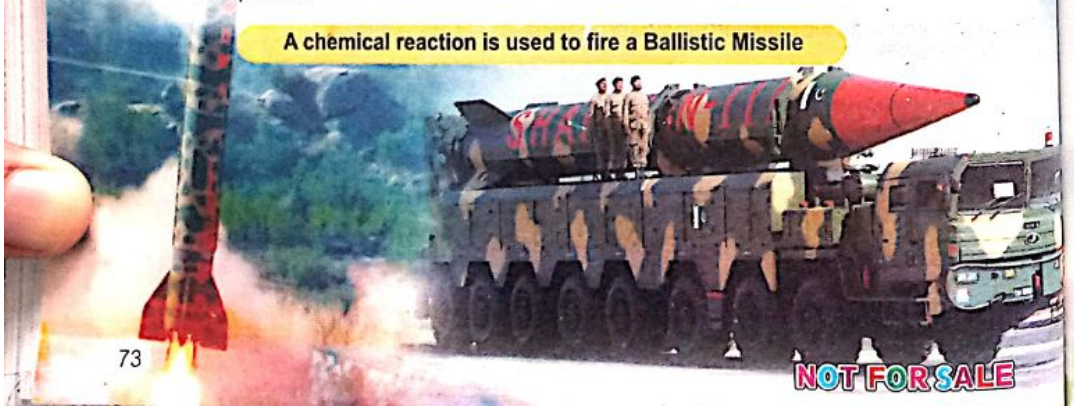
UNIT 6

CHEMICAL REACTIONS AND BONDING

Learning outcomes:

At the end of this unit, students will be able to:

- Identify chemical reactions and give examples.
- Define the Law of Conservation of Mass and demonstrate the law with an experiment.
- Write and balance chemical equations.
- Distinguish between different types of reactions (combination, displacement, double displacement, combustion)
- Distinguish between endothermic and exothermic reactions.
- Recognize the importance of exothermic and endothermic reactions in daily life.
- Discuss formation of ionic bonds as a result of electrostatic forces between atoms (e.g., NaCl)
- Discuss types and formation of covalent bond as a result of mutual sharing of electrons between atoms (e.g., H_2, O_2, N_2).
- Name certain ionic and covalent compounds.
- Draw cross and dot structures showing formation of ionic compounds and covalent compounds



A chemical reaction is used to fire a Ballistic Missile

In grade 7, you have learned about physical and chemical changes in terms of transformation of one or more pure substances into different pure substances. This knowledge will help you to understand this unit.

Chemical reactions are occurring all around us and in our body. A plant needs sugar for its growth. Plants prepare this sugar from carbon dioxide and water in the presence of sunlight. Plants use this sugar in building up their structure and many compounds for our use. Our bodies get useful compounds from plants and convert them into other useful compound for their growth. This means our existence depends upon chemical reactions.

6.1 CHEMICAL REACTIONS

What happens when you light up a match stick? It burns and changes into carbon dioxide, water and ash. Conversion of match stick into carbon dioxide, water and ash is a result of chemical reaction.

A chemical change is referred as a chemical reaction.

Whenever a chemical reaction occurs new substances are formed.

We can define a chemical reaction as the conversion of a substance into new substance.

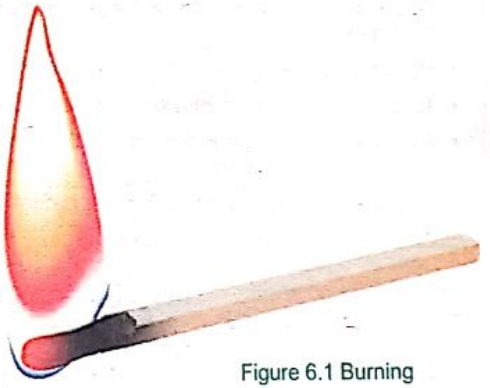


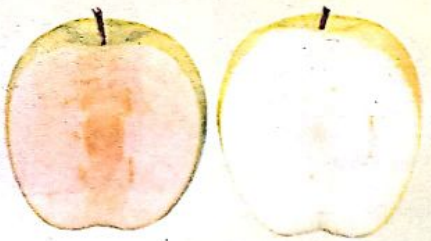
Figure 6.1 Burning

How do we know whether a chemical reaction has taken place?

How can you tell this has happened?

DO YOU KNOW?

When you cut an apple and place it in air. It turns brown after some time. This is due to a chemical reaction. Iron present in apple combines with oxygen of the air and forms a new substance, iron oxide which is yellow brown.



$$Fe^{2+} \xrightarrow{\text{Oxidation}} Fe^{3+}$$

Light green — Yellow brown

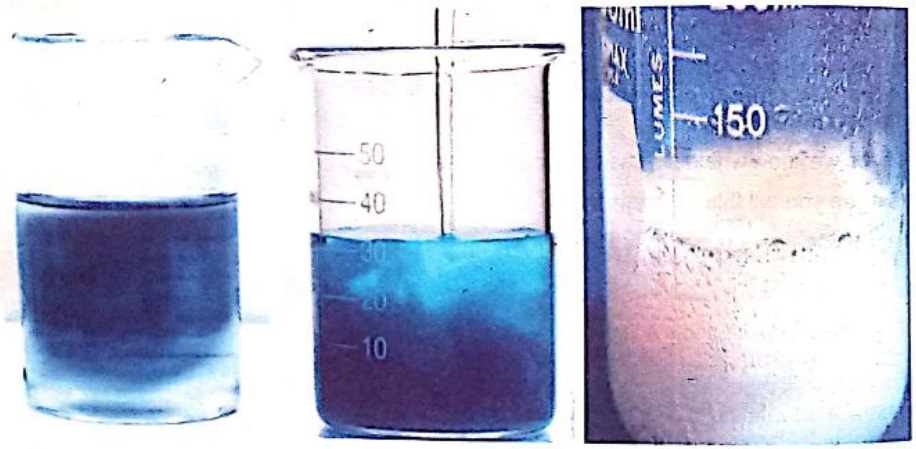
Activity 6.1 Identifying signs of a chemical reaction

Materials required:

- Beaker, test tubes.
- Solutions of iodine, starch, copper sulphate, sodium hydroxide.
- Vinegar and baking soda.

Procedure:

- Arrange three beakers on the table and label them as 1, 2, 3.
- Add half test tube of starch solution in the first beaker. Add few drops of iodine solution in it.
- Record your observation.
- Add 2 cm^3 of copper sulphate solution in the second beaker. Add few cm^3 of sodium hydroxide solution in it.
- Record your observation.
- Touch the outer side of this beaker with your hand. Record your observation.
- Add 25 cm^3 of vinegar in the third beaker. Add about half spoon of baking soda in it. Record your observation.
- Touch the outer side of this beaker with your hand. Record your observation.



1 2 3

Figure 6.2 Signs of chemical reactions

UNIT 6 CHEMICAL REACTIONS AND BONDING

Conclusion:

1. The colour changed from brown to blue in the first beaker shows formation of a new compound.
2. In the second beaker blue precipitate formed. This happens when a chemical reaction produces a solid from mixing solutions.
3. Effervescence occurred in the third beaker. This happens when a chemical reaction gives off a gas.
4. Coldness of the third beaker indicates that heat is absorbed in this reaction.

To identify a chemical reaction, we should look for a chemical change. A chemical change can be identified by the following observations.

i) Colour change
ii) Formation of precipitate
iii) Emission of a gas
iv) Odour change
v) Temperature change

DO YOU KNOW?

Butter develops unpleasant taste and bad odour when placed in open air for some days. Chemical action of bacteria converts butter fat into butyric acid, which has bad taste and bad odour.

DO YOU KNOW?

Precipitation is the formation of an insoluble solid when two solutions are mixed or a gas is bubbled into a solution.

Examples of chemical reactions

i) **Burning coal and natural gas (methane):**

Coal is carbon, when it burns in air it produces carbon dioxide.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

When methane burns in air, carbon dioxide and water vapours are formed.

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

ii) Rusting of iron.

$$4Fe_{(s)} + 3O_{2(g)} \xrightarrow{H_2O} 2Fe_2O_{3(s)}$$

Iron Oxygen iron oxide(rust)

iii) Photosynthesis is a chemical reaction in which plants combine carbon dioxide and water to produce glucose. This reaction occurs in presence of sunlight and chlorophyll.

DO YOU KNOW?

When a substance reacts with oxygen and releases energy, the reaction is called as combustion. If flame is also produced, it is described as burning.

Try it out

Design an experiment to show that odour change is a sign of chemical reaction.

Teaching Point: Teacher may help students to perform this activity with butter.

6.2 CHEMICAL EQUATION AND BALANCING

The symbolic representation of a chemical reaction is a called chemical equation.

Reactants → Products

For instance, we can describe, burning of coal as follows.

Coal is carbon.

Carbon + Oxygen → Carbon dioxide

Now simplify the word chemical equation by writing symbols and formulae of reactants and products. Indicate their physical states in parenthesis. Use "s" for solid , "l" for liquid, "g" for a gas and aq for aqueous.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

Similarly burning of natural gas (methane) is described as follows:

Methane + Oxygen → Carbon dioxide + Water

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

The symbolic representation of a chemical reaction is called chemical equation.

Represent the following chemical reactions by chemical equations.

i) Burning of hydrogen (H_2) to produce water.

ii) Burning of magnesium (Mg) to produce magnesium oxide (MgO).

UNIT 6 CHEMICAL REACTIONS AND BONDING

Balancing a Chemical Equation

A chemical reaction only changes the arrangements of atoms. The number of atoms remains the same. Count the number of atoms of each type in the following chemical equation:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

Reactants	Products
1 C-atom	1 C-atom
2 O-atoms	2 O-atoms

Note the number of each type of atoms is the same on the reactant side and the product side. Such a chemical equation is called a balanced chemical equation. How can you balance a chemical equation if it is unbalanced?

Example 4.1

Natural gas burns in air to form carbon dioxide and water. Write a balanced chemical equation for this chemical reaction.

Problem solving strategy

i) Write word equation.

Methane + Oxygen → Carbon dioxide + Water

ii) Write correct symbols and formulae of reactants and products. Also indicate in parenthesis the physical states in which reactants and products exist.

$$CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$$

iii) Count the number of atoms of each element in the reactants and products:

$$CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$$

Reactants	Products
1C - atom	1C - atom
4H - atoms	2H - atoms
2O - atoms	3O - atoms

C atoms are balanced, but H and O atoms are not balanced.

iv) Balance one element at a time. To balance the chemical equation use co-efficients. When no co-efficient is written, it is assumed to be 1. Always start with the lowest co-efficient. You should not change subscripts in a chemical formula to balance a chemical equation.

v) Put a co-efficient 2 before H_2O to balance H atoms.

$$CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

vi) Now balance O atoms, there are 2O atoms on left side and 4O atoms on the right side. Put 2 before O_2.

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

Example 4.2

Balance the following chemical equation:

$$Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2(g)}$$

Solution:

$$Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2(g)}$$

1 Na - atom	1 Na - atom
2 H - atoms	3 H - atoms
1 O - atom	1 O - atoms

Na and O atoms are balanced. H is unbalanced. What to do? You can't show 3H atoms on the left side.

So, Put 2 before NaOH, so H-atoms become even on the right side.

$$Na_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

Now balance H atoms.

$$Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

H atoms are balanced on both the sides, but Na atoms become unbalanced. Put 2 before Na on the left side.

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

This chemical equation is now balanced.

Point to remember

We cannot alter the chemical formulae of substances involved in a chemical reaction.

Teaching Point: Give more examples of balancing chemical equations. Give at least ten chemical equations for balancing as assignment.

Balance the following chemical equations

i) $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(g)}$

ii) $Ca_{(s)} + O_{2(g)} \rightarrow CaO_{(s)}$

iii) $H_2O_{2(l)} \rightarrow H_2O_{(l)} + O_{2(g)}$

iv) $Ag_{(s)} + O_{2(g)} \rightarrow Ag_2O_{(s)}$

UNIT 6 CHEMICAL REACTIONS AND BONDING

6.3 LAW OF CONSERVATION OF MASS

A balanced chemical equation is based on the principle that atoms are neither created nor lost in a chemical reaction. So total mass of reactants and products is conserved. This principle is called law of conservation of mass.

The law of conservation of mass states that the total mass of all the products of a chemical reaction is equal to the total mass of all the reactants.

Activity 6.2 Studying the law of conservation of mass

Materials required:

- Conical flask, test tube.
- Solutions of calcium chloride and sodium sulphate.
- Top loading balance.

Procedure:

- Place 50 cm^3 of sodium sulphate solution in the conical flask.
- Place 20 cm^3 of calcium chloride in the test tube.
- Place this test tube in the conical flask.
- Now weight conical flask. Record its mass.
- Mix the two solutions carefully, what happens?
- Weigh the whole apparatus again. Record its mass.
- Compare the mass before and after the chemical change.

Conclusion:

When calcium chloride and sodium sulphate solutions are mixed together, a chemical reaction takes place.

$$Na_2SO_{4(aq)} + CaCl_{2(aq)} \rightarrow 2NaCl_{(aq)} + CaSO_{4(s)}$$

- Total mass of products is equal to the total mass of reactants.

6.4: TYPES OF CHEMICAL REACTIONS

Synthesis reaction:

A chemical reaction in which two or more substances combine to form a single compound is called synthesis reaction. It is also called addition or combination reaction.

For example, when carbon burns in air, it combines with oxygen producing carbon dioxide.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

During electrical discharges in the atmosphere nitrogen combines with oxygen to produce nitric oxide (NO)

$$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$$

DO YOU KNOW?

Synthesis reactions have many industrial applications. Addition of hydrogen to vegetable oil in the presence of a catalyst is used to convert them into vegetable ghee and margarine.

Decomposition reaction:

A chemical reaction in which a single compound breaks down into two or more simple substances is called a decomposition reaction.

Examples of decomposition reactions:

$$2AgCl_{(s)} \xrightarrow{sunlight} 2Ag_{(s)} + Cl_{2(g)}$$

Silver chloride Silver Chlorine

$$2NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)}$$

Ammonia Nitrogen Hydrogen

DO YOU KNOW?

Decomposition reactions are used in industries for producing many important substances. For instance decomposition of lime stone is used for the production of lime (calcium oxide) which is a major constituent of cement.

$$CaCO_{3(s)} \xrightarrow{heat} CaO_{(s)} + CO_{2(g)}$$

STOP AND CHECK

Commercially sodium is obtained by passing electricity through molten NaCl, Cl_2 is also produced in this reaction.

i) Write a balanced chemical equation for this reaction.

ii) Name the type of reaction.

UNIT 6 CHEMICAL REACTIONS AND BONDING

Displacement reaction:

A chemical reaction in which a more reactive element takes the place of a less reactive element in a compound is called displacement reaction. For example Zn can displace hydrogen from acids.

$$Zn_{(s)} + H_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_{2(g)}$$

Iron can be extracted from iron oxide (Fe_2O_3) by heating with Coke (Carbon).

$$2Fe_2O_{3(s)} + 3C_{(s)} \longrightarrow 4Fe_{(s)} + 3CO_{2(g)}$$

Double displacement reaction:

A chemical reaction in which two atoms or groups of atoms exchange places and form new compounds is called double displacement reaction.

For example the reaction between an acid and base produces new compounds, NaCl and H_2O.

$$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$

When silver nitrate ($AgNO_3$) solution is added to sodium chloride solution, a double displacement reaction occurs and new compounds silver chloride and sodium nitrate are formed.

$$AgNO_{3(aq)} + NaCl_{(aq)} \longrightarrow AgCl_{(s)} + NaNO_{3(aq)}$$

Combustion reaction:

A chemical reaction between substances and oxygen in which CO_2, heat and light is generated, is called a combustion reaction. Light is emitted in the form of flame. For example burning of coal in air.

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)} + heat + light$$

Burning of methane (sui gas) is a combustion reaction.

$$CH_{4(s)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)} + heat + light$$

Teaching Point: Teacher may give more examples of chemical reactions and ask students to classify them.

6.5 ENERGY CHANGES IN CHEMICAL REACTIONS

Exothermic and Endothermic

Chemical reactions involve energy changes.

Recall when copper sulphate and sodium hydroxide solutions are mixed, beaker becomes cold But when vinegar is mixed with baking soda, beaker becomes hot. Which of the given figures shows that heat is absorbed in the chemical reaction?

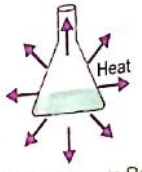


Figure 6.3 Exothermic Reaction

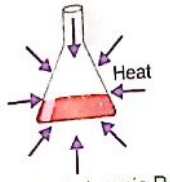


Figure 6.4 Endothermic Reaction

A chemical reaction that evolves heat or light into their surroundings is called an exothermic reaction. Exothermic is basically Greek word. Exo means to evolve and therm means heat.

For example, burning is an example of exothermic reaction. When natural gas burns, both heat and light is produced.

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)} + heat + light$$

Other examples of exothermic reactions are:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} + heat + light$$

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + heat$$

A chemical reaction that absorbs energy from its surroundings is called an endothermic reaction. Endothermic is also a Greek word. Endo means 'to absorb' and therm means 'heat'. For instance, when lime stone is heated at 1000 °C, it decomposes. It is an endothermic reaction. It can be written as follows:

$$CaCO_{3(s)} + heat \rightarrow CaO_{(s)} + CO_{2(g)}$$

When electricity is passed through water, it decomposes to produce hydrogen and oxygen. It is also an endothermic reaction.

$$2H_2O_{(l)} \xrightarrow{Electricity} 2H_{2(g)} + O_{2(g)}$$

All endothermic reactions need a continuous source of energy. Whereas exothermic reactions may require a source of energy in the beginning of the process. But later on continue on their own.

The plants combine carbon dioxide and water and produce glucose and oxygen. This reaction is called photosynthesis. It occurs only in sunlight. So, photosynthesis, is a natural endothermic reaction. This reaction is essential for life, as it produces food and oxygen for all living organisms.

$$6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(aq)} + 6O_{2(g)}$$

Carbon dioxide Water Glucose Oxygen

Another naturally occurring endothermic reaction is vital for life on Earth is following.

In the upper atmosphere ozone (O_3) absorbs harmful ultraviolet rays and changes into oxygen. Ozone layer protects the living things on the Earth from dangerous ultraviolet rays of the sun.

$$2O_{3(g)} \xrightarrow{Ultraviolet\ Light} 3O_{2(g)}$$

UNIT 6 CHEMICAL REACTIONS AND BONDING

Activity 6.3 Endothermic reactions

Observing energy change in an endothermic chemical reaction.

Material required:

- Baking soda
- 50 cm^3 of vinegar
- Thermometer
- Beaker

Procedure:

- Place 50 cm^3 of vinegar in the beaker.
- Suspend a thermometer in it. Leave it for five minutes, then record its temperature.
- Add about half spoon of baking soda in the beaker and shake it.
- Observe changes.
- Feel the outside of the beaker with your fingers.
- Observe change in temperature and record the final temperature.

Conclusion:

What change did you detect with your sense of touch? Thermometer shows a decrease in temperature. This means that this chemical reaction absorbs energy from its surroundings. So the reaction between vinegar and baking soda is endothermic.

Activity 6.4 Exothermic reactions

Observing energy change in an exothermic chemical reaction.

Materials required:

- Calcium chloride, magnesium sulphate.
- 50 cm^3 water, beaker, glass rod.
- Thermometer.

Procedure:

- Put 50 cm^3 of water in a beaker.
- Suspend a thermometer in it. Leave it for some time. Record its temperature.
- Add one spoon of calcium chloride and one spoon of magnesium sulphate in water.
- Stir this mixture with a glass rod.

Activity 6.4 Cont...

- Observe change in temperature.
- Feel the outside of the beaker with your fingers.
- Record final temperature.

Conclusion:

What change did you detect with your sense of touch? Thermometer shows a rise in temperature. So this is an exothermic reaction.

Using Exothermic Reactions

We need energy to perform various activities. Where does this energy come from?

- An exothermic reaction takes place in our bodies in every cell. In this reaction glucose molecules combine with oxygen and break down into carbon dioxide and water and release energy. This energy maintains all the vital functions of our body. It also keeps us warm, and enable body parts and muscles working.

$$C_6H_{12}O_{6(aq)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$$

- Fuels such as coal, natural gas and LPG (liquefied petroleum gas) burn with flame and release a lot of energy. We use this energy to cook food, boil water, warm homes during winter, derive vehicles and generate electricity.
- Batteries are source of electricity. An exothermic reaction keeps the batteries in our cell phone and laptops functioning. We also use a battery to start engines in automobile and for devices such as flash light, toys, heart pacers, electronic calculators.

Figure 6.5 Performing exercises

Figure 6.6 LPG Cylinder

Figure 6.7 Batteries

DO YOU KNOW?

Sherbet sweets contain a mixture of dry citric acid and sodium hydrogen carbonate. When you eat it, these substances dissolve in your saliva and react together. An endothermic reaction occurs. This gives a cool, fizzy and refreshing feeling in your mouth.

Using Endothermic Reactions:

- What happens when you bake a cake?
- When cake dough is heated in an oven, an endothermic reaction occurs. Heat absorbed changes cake dough into a fluffy and delicious material.
- Instant cold packs are used to treat injuries such as muscles sprains and strains. Instant cold packs has two compartments separated by breakable partition. Each compartment contains ingredients which when mixed cause an endothermic reaction. Therefore create cooling effect in the surroundings. So, when cold pack is kneaded, this reaction occurs. When cold pack is placed on the injury. Temperature drop reduces swelling and pain.
- Plants use solar energy to make their food from carbon dioxide and water in presence of chlorophyll.

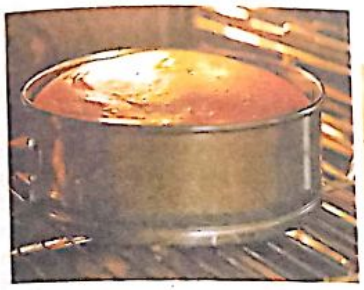


Figure 6.8 Cake

Figure 6.9 Instant cold pack

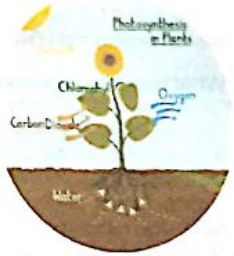


Figure 6.10 Photosynthesis

6.6 CHEMICAL BONDS

Chemical Bonds

Atoms combine to form various types of substances. What holds them together in a substance. Fundamentally, some forces of attraction hold atoms together in substances. These forces are called chemical bonds. Electronic structure of an atom helps us to understand how atoms are held together in a substance. Atoms of noble gases have no tendency to react with other elements. The atoms of noble gases already have complete valence shells. Helium contains 2 electrons in valence K shell. Other noble atoms have 8 electrons in their valence shell. So, they have no tendency to lose, gain or share electrons. Atoms other than noble gases have a tendency to react with the atoms of other elements. This is because they do not have complete valence shells. They tend to gain, lose or share electrons to acquire the electronic configuration of next noble gas.

TYPES OF BONDS

Depending on the tendency of an atom to lose or gain or share electrons, there are two types of bonds.

1. Ionic bonds
2. Covalent bonds

Ionic Bond:

Ionic bonds are formed between two atoms, when an atom loses electron to form cation and the other gains this to form anion. Cations and anions have opposite charges. They attract one another by electrostatic forces.

The force of attraction that binds oppositely charged ions is called Ionic bond.

Compounds that consists of ions joined together by electrostatic forces are called ionic compounds. Ionic bonds are found in compounds that contain metals combined with non-metals. Recall that metal atoms form cations and non-metal atoms form anions. In the formation of ionic bond, electrons are transferred from the metal atoms to the non-metal atoms during the chemical reaction.

What happens when sodium and chlorine combine to make sodium chloride (NaCl)?

Sodium atom has only one electron in its outermost or valence shell. Chlorine has 7 electrons in its valence shell. It needs only one electron to complete its valence shell. When these two elements react, the outer electron of each sodium atom is transferred to the outer shell of each chlorine atom. After losing one electron each sodium atom has become sodium ion (Na^+). Its remaining outermost shell has eight electron. After gaining one electron each chlorine atom has become chloride ion (Cl^-). Its outermost shell also has eight electrons. In this way both the atoms acquire nearest noble gas electron structure. These oppositely charged ions are pulled to one another by strong electrostatic forces. This type of bonding is called ionic bonding.

We can represent the formation of ionic bond between sodium and chlorine atoms by using electron-dot and electron-cross structures.

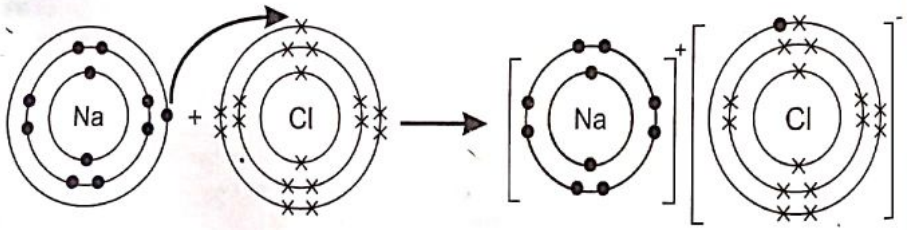


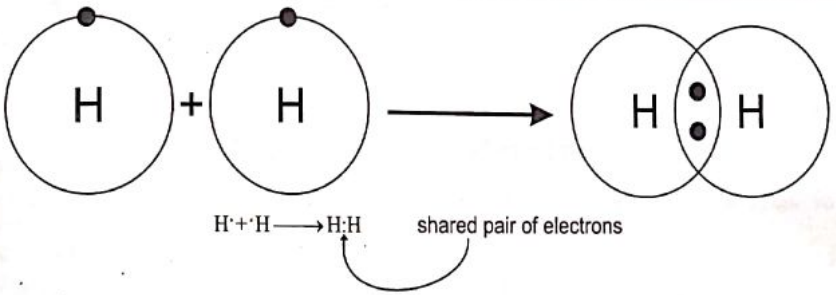
Table: Some ionic compounds used in everyday life

Ionic compound	Use
NaCl, Sodium chloride	Ordinary table or common salt.
NaF, Sodium fluoride	Ingredient in toothpaste
$NaHCO_3$, Sodium hydrogen carbonate	Used as baking soda and antacid
Na_2CO_3, Sodium carbonate	Ingredient in cleaning agents
$CaCO_3$, Calcium carbonate	Used in making cement, lime and carbon dioxide
NaOH, Sodium hydroxide	Used in making drain cleaner and soap

Covalent Bond:

The bond formed by mutual sharing of electrons between two atoms is called covalent bond.

Consider the formation of covalent bond in hydrogen molecule. A hydrogen atom has a single valence electron. Two hydrogen atoms share their valence electrons to form a diatomic molecule.



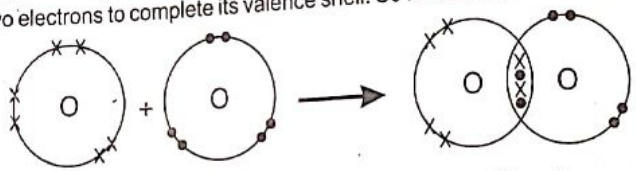
In the formation of this molecule, each hydrogen atom achieves the electron configuration of the noble gas, helium which has two valence electrons. An electron pair in the region between the two atoms is attracted to both hydrogen nuclei. This means it is a more stable situation than that exists in separate atoms. Because of this stability two atoms form a covalent bond.

We can represent the formation of a covalent bond between two atoms using electron-dot and electron-cross symbols for the atoms and the resulting molecule. A shared pair of electrons is also represented by a dash (-) in a molecule.

Covalent bond is formed by the sharing of one electron pair is called single covalent bond.
So hydrogen molecule contain a single covalent bond.

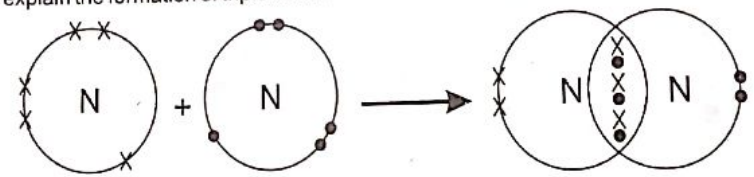
Sometimes atoms may share two or three electron pairs to complete their valence shell. **Double covalent bonds are the bonds that are formed by sharing of two electron pairs between two atoms. Triple covalent bonds are the bonds that involve three shared electrons pairs between two atoms.**

Consider the formation of O_2 molecule. Oxygen is in Group VI A, so it has 6 electrons in the valence shell. It needs two electrons to complete its valence shell. So for sharing each O-atom contributes two electrons



or $\overset{\times\times}{\underset{\times}{O}}=\overset{\bullet\bullet}{\underset{\bullet}{O}}$

. Can you explain the formation of triple bond between two nitrogen atoms to form N_2 molecule?



or $\overset{\times}{\underset{\times}{N}}\equiv\overset{\bullet}{\underset{\bullet}{N}}$

Table: Some covalent compounds used in everyday life

Covalent Compound	Use
H_2O, Water	No living thing can survive without it. It is used for drinking, cooking, cleaning, in agriculture and industries.
$C_6H_{12}O_6$, Glucose	Ingredient in baking, cooking and beverages.
CH_3COOH, Vinegar	As preservative and seasoning food and salad.
$C_7H_8O_4$, Aspirin	To treat pain, fever and inflamations.

Teaching Point: Teacher may explain the formation of water molecule by electron-dot and electron-cross structures.

UNIT 6 CHEMICAL REACTIONS AND BONDING

Key Points

- A chemical change is called a chemical reaction.
- Burning is a chemical change.
- Color change, emission of a gas, formation of precipitate, odour and temperature change are signs that indicate a chemical reaction has taken place.
- The chemical equation is the representation of a chemical reaction.
- A chemical reaction only changes the arrangements of atoms.
- While balancing a chemical equation, do not change the chemical formulae.
- Law of conservation of mass states that the total mass of reactants and products is conserved.
- In a synthesis reaction, two or more reactants combine to form a single product.
- In a decomposition reaction one reactant produces two or more products.
- In a displacement reaction a more reactive element takes the place of less reactive element.
- In a double displacement reaction two atoms or group of atoms exchange their places.
- In an exothermic reaction heat is evolved.
- In an endothermic reaction heat is absorbed.
- The force of attraction that binds oppositely charged ions is called ionic bond.
- The bond formed by mutual sharing of electrons between two atoms is called covalent bond.
- A covalent bond formed by the sharing of one electron pair is called a single covalent bond.
- A covalent bond formed by the sharing of two electron pairs is called a double covalent bond.
- A covalent bond formed by the sharing of three electron pairs is called a triple covalent bond.

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. Which of the following group contains alkali metals?
   a. II A b. III A c. VII A d. I A
2. The reaction between sodium and water produces
   a. H_2 b. O_2 c. $NaCl$ d. Na_2CO_3
3. Photosynthesis in green plants is
   a. synthesis. b. decomposition. c. combustion. d. endothermic.

4. The reaction between magnesium and hydrochloric acid is:

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

Which substance indicates the reaction has taken place?

a. Mg b. HCl c. H_2 d. $MgCl_2$

5. Which of the following reaction is unbalanced?

a. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ b. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$

c. $KClO_{3(s)} \rightarrow KCl_{(s)} + O_{2(g)}$ d. $Ca_{(s)} + S_{(s)} \rightarrow CaS_{(s)}$

6. An endothermic reaction occurs when

a. carbon burns in air.

b. electrical discharges in the atmosphere nitrogen combines with oxygen.

c. natural gas burns in air.

d. hydrogen combines with oxygen to form water.

7. Which of the following is not a chemical reaction?

a. Rusting b. Frying an egg c. Photosynthesis d. Melting of ice

8. When copper sulphate solution is mixed with sodium hydroxide solution, the chemical reaction is indicated by:

a. Emission of a gas b. Odour change

c. Temperature change d. Formation of precipitate

9. What happens when few drops of iodine solution is added in starch solution?

a. Gas is emitted b. Precipitates are formed

c. Colour change occurs d. Bad odour is emitted

10. Which of the following is not a balanced chemical reaction?

a. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$ b. $H_{2(g)} + O_{2(9)} \rightarrow 2H_2O_{(l)}$

c. $C_{(s)} + O_{2(s)} \rightarrow CO_{2(g)}$ d. $2NH_{3(g)} \rightleftharpoons N_{2(q)} + 3H_{2(g)}$

B. Short questions

i). What is a chemical reaction? Give two examples.

ii). State the law of conservation of mass.

iii). Write a balanced chemical equation for the reaction between methane and oxygen.

iv). Show formation of NaCl by electron-dot and electron-cross structures

v). Show the formation of MgO by electron-dot and electron-cross structure (Atomic number Mg=12, O=8)

vi). Define the following:

a) Double covalent bond b) Triple covalent bond

UNIT 6 CHEMICAL REACTIONS AND BONDING

vii). What is a double displacement reaction? Give one example.

viii). Give one example for each of the following reactions.

a) Combination b) Combination c) Displacement

ix. Give one example of each of the following from daily life.

a) Exothermic reaction b) Endothermic reaction

x). Show the formation of covalent bond between hydrogen and chlorine.

C. Long questions

1. Discuss the formation of ionic bond with an example.
2. What are covalent bonds? Discuss its types.

D. Structured response questions

i). When coal burns it produces carbon dioxide and leaves ash behind. Ash produced in this reaction is lighter than coal.

a) Does this contradict the law of conservation of mass? Justify your answer.

b) Classify this reaction

c) Write a balanced chemical equation for this reaction.

ii). Element X is in Group IA and element Y is in Group VIIA.

a) What type of bond between them will be formed? Explain.

b) Draw electron-dot and electron-cross structures to show the formation of bond between them.

iii). Classify the following reactions as exothermic or endothermic reaction.

a) Combustion b) Decomposition c) Neutralization

d) Reaction between baking soda and vinegar

iv) Two chemical reactions are occurring in Beaker A and Beaker B. In beaker A, temperature changes from 25°C to 40°C. In beaker B, temperature changes from 25°C to 20°C.

a) What are the changes in temperature in these beakers?

b) Which of these reactions is exothermic and endothermic? Explain.

E. Project work

Drizzle baking powder all over the wash basin in your toilet. Squeeze the lemon juice on top of it to make the powder wet. Now scrub the wash basin with a soft scrubber for 2 to 3 minutes. Leave it as such for 5 minutes. Then wash it off with plain water. What do you observe? Prepare a report.

UNIT 7

ACIDS, BASES AND SALTS

Learning outcomes:

At the end of this unit, students will be able to:

- Classify acids, Alkalies, and salts and give examples of each.
- Identify the physical properties of acids, Alkalies, and salts.
- Define pH and its ranges with reference to indicators.
- Interpret the pH scale and identify acids, Alkalies, and salts.
- Describe the neutralisation reaction with real life examples.
- Observe and write the uses of acids, bases, and salts in daily life.

7.1 INTRODUCTION TO ACIDS, BASES AND SALTS

Figure 7.1 Fruits which contain acids

Acids

Many fruits such as lemon, orange, grapes, etc. taste sour. What makes them sour? There must be a substance in these fruits that makes them sour. This substance is called an acid. The word acid is derived from Latin word "acidus" meaning sour.

An acid is a substance that contains a hydrogen atom bonded, which ionizes in aqueous solution to produce hydrogen (H^+) ions. This hydrogen ion makes acid taste sour. So an acid is defined as follows.

An acid is a substance that gives hydrogen ions (H^+) when dissolved in water.

$$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)} \qquad H_2SO_{4(aq)} \rightarrow 2H^+_{(aq)} + SO^{2-}_{4(aq)}$$

Hydrochloric acid (HCl) contains one ionizable hydrogen. How many ionizable hydrogen are present in sulphuric acid (H_2SO_4)?

HCl, H_2SO_4 and carbonic acid are derived from minerals and are called mineral acids. The acids present in animals and plants materials are known as organic acids. For instance, acetic acid (CH_3COOH) is obtained from vinegar, formic acid (HCOOH) is present in bee sting etc.

Acids are also classified on the basis of ionizing capacity. Acids that ionize in water completely are called strong acids. For example: *HCl*, H_2SO_4, HNO_3 etc.

Acids that ionize in water partially are called weak acids. For example: Vinegar, formic acid, carboni

Table: Some Common Mineral Acids

Name	Chemical Formula
Hydrochloric acid	HCl
Nitric acid	HNO_3
Sulphuric acid	H_2SO_4
Phosphoric acid	H_3PO_4

Table: Some Organic Acids

Name	Chemical Formula
Carbonic acid	H_2CO_3
Acetic acid	CH_3COOH
Formic acid	$HCOOH$
Citric acid	$C_6H_8O_7$

DO YOU KNOW?

Carbonic acid is formed by dissolving carbon dioxide in water. This acid is present in fizzy drinks such as soda water. Phosphoric acid is present in cola drinks.

Bases

What happens when soap lather gets into your eyes? Which substance produces irritation and burning in eyes? Soaps, detergents and shampoos have bitter taste. Which substance makes them bitter? This substance is called a base. Bases contain hydroxyl group (OH), which dissociates or ionizes in aqueous solution to produce hydroxide ions. These hydroxide ions make bases taste bitter.

A compound that has a bitter taste is called a base. A base that dissolves in water is called an alkali. Like acids, alkalies are very common substances which are found in home and industry. The word alkali is derived from Arabic word "qali" meaning from ashes. Alkalies were first obtained from ashes of plants.

alkalies are the compounds that produce hydroxide ions (OH^-) when dissolved in water. For example, sodium hydroxide, potassium hydroxide, etc.

$$NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

$$KOH_{(aq)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$$

alkalies are also classified on the basis of ionizing capacity. alkalies that ionize in water completely are called strong alkalies. For example; NaOH, KOH. alkalies that ionize in water partially are called weak alkalies. For example: NH_4OH, $Cu(OH)_2$, $Al(OH)_3$ etc.

UNIT 7 ACIDS, BASES AND SALTS

Table: Some Common Basis

Name	Chemical Formula
Sodium hydroxide (caustic soda)	$NaOH$
Potassium hydroxide (caustic potash)	KOH
Calcium hydroxide (slaked lime)	$Ca(OH)_2$
Ammonium hydroxide	NH_4OH
Magnesium hydroxide (Milk of magnesia)	$Mg(OH)_2$

Salts

What are the main products formed when acids react with alkalies? We can write a general word equation for this reaction.

$$Alkali + Acid \rightarrow Salt + Water$$

The word salt is used to describe a group of compounds formed from acids. All simple acids contain one or more replaceable hydrogen. When such a hydrogen is replaced by a metal, the resulting compound is called a salt. For example when hydrogen from hydrochloric acid is replaced by sodium, the resulting compound sodium chloride (NaCl) is a salt. Sodium sulphate Na_2SO_4 is produced from sulphuric acid. Which acid forms nitrates?

Normal salts: A salt that does not contain any replaceable hydrogen atom or hydroxyl group is called normal salt. They are formed by complete neutralization of acid and base. Examples: $NaCl$, Na_2SO_4, $CaSO_4$, KCl etc.

Acid salts: A salt that contains replaceable hydrogen atoms is called an acid salt. Examples: $NaHCO_3$, $NaHSO_4$ etc.

Basic salts: A salt that contains replaceable hydroxyl group is called basic salt. Examples: $Zn(OH)Cl$, $Pb(OH)Cl$

Double salt: A salt that contains two different cations or anions is called double salt.

Examples: **Dolomite** $CaCO_3.MgCO_3$, **Alum** $K_2SO_4.Al_2(SO_4)_3.24H_2O$

Indicators

The easiest way to detect an acid or an alkali is to use an indicator. **Indicators are substances that change colour when added to an acid or alkali.** The most common indicator is litmus. It turns red in an acid and turns blue in an alkali.

7.2 PROPERTIES OF ACIDS, ALKALIES AND SALTS

Properties of Acid

(i) Acids have a sour taste.

(ii) Acids turn blue litmus paper red.

(iii) Acids are water soluble

(iv) Acids in aqueous solutions are known as electrolytes as they conduct electricity

DO YOU KNOW?

- Citrus fruits contain citric acid.
- Apple contains malic acid.
- Grapes contain tartaric acid.

Activity 7.1 Effects of acids on Litmus paper

Materials required:

Lemon juice, vinegar, apple, blue and red litmus paper, beakers.

Procedure:

- Take some lemon juice and vinegar in separate beakers.
- Dip red and blue litmus paper in each solution, one by one.
- Record your observation.
- Cut an apple and place blue and red litmus paper on its cut surface. Press paper a little.

Record your observation.

Figure 7.2 Acids turn blue litmus paper red

Teaching Point: Teacher should explain corrosive nature of acids.

Properties of Alkalies

i) Alkalies have bitter taste.

ii) Aqueous solution of an alkali has slippery touch.

iii) Alkalies turn red litmus paper blue.

iv) Alkalies in aqueous solutions are known as electrolyte as they conduct electricity

Activity 7.2 Effects of alkalies on Litmus paper

Materials required:

Sodium hydroxide, water, blue and red litmus paper, beakers.

Procedure:

- Transfer 10 cm^3 of water in a beaker.
- Add two pellets of sodium hydroxide and mix it well.
- Divide this solution into two parts and dip blue litmus paper in one part and red litmus paper in the second part.

Record your observation:

1. _____
2. _____
3. _____

Figure 7.3 An alkali turns red litmus paper blue

Teaching Point: Teacher should explain the corrosive nature of alkalis.

Properties of salts

- Salts are crystalline solids. Some salts may exist in powder form.
- They have high melting and boiling points.
- Generally salts are soluble in water. For example, sodium chloride, potassium chloride, sodium carbonate, etc.
- Some salts are insoluble in water. For instance, calcium carbonate, magnesium carbonate, lead sulphate, etc.

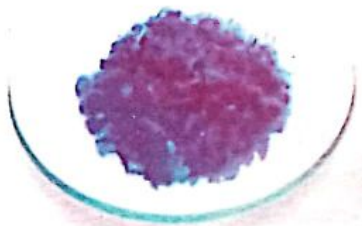


Figure 7.4 Crystals of Copper Sulphate

- Aqueous solutions of salts or their molten forms are good conductors of electricity.
- Some salts also contain water molecules in their crystals e.g. copper sulphate.

7.3 USES OF ACIDS, ALKALIES AND SALTS

Uses of Acids

We use acids in many ways.

- Acetic acid is the main component of vinegar, which is used in salad dressings, adding flavour to food and making pickles.
- Hydrochloric acid is naturally produced in our stomach and is the main component of gastric juice. It aids in digestion of food.
- Dilute sulphuric acid (30%) is used in the lead battery in your automobiles.
- In industry, sulphuric acid is used to manufacture fertilizers, artificial fibres, paints, dyes, and refining of petroleum.
- Citric acid is used as flavouring agent and preservative in sauces and pickles.
- Phosphoric acid is used in cola drinks.
- Carbonic acid is used in fizzy drinks.
- Nitric acid is used in making fertilizers and explosives.

DO YOU KNOW?

Aspirin contains an acid called acetylsalicylic acid. Ascorbic acid is used as vitamin C.

Uses of Alkalies

The common uses of alkalies are:

- Sodium hydroxide is used in oven cleaners as degreasing agent. It converts oil and grease into soluble soaps that can be washed away easily.
- Sodium hydroxide is used in making soaps, paper pulp, medicines and petroleum refining.
- Calcium hydroxide is used in the manufacture of bleaching powder and to neutralise soil acidity.
- Ammonium hydroxide is used in cleaning fluids in home and making fertilizers.
- Magnesium hydroxide is used as an antacid to neutralise excess acid in your stomach and cure indigestion.

Uses of salts

Salts are widely used in homes and in industries.

- Sodium chloride is essential for life. It is involved in muscle contraction and conduction of nerve impulses. It is also converted into hydrochloric acid in our stomach.
- In industry, sodium chloride is used in the manufacture of important chemicals such as sodium hydroxide, baking soda, washing soda and soda ash.
- Calcium carbonate (marble, lime stone) is used for making decorative stones, lime and cement.
- Potassium nitrate is used as fertilizer and in making gun powder.
- Sodium carbonate (washing soda) is used in cleaning, water softening and making glass.
- Ammonium nitrate and ammonium sulphate are used as fertilizers.

7.4 NEUTRALISATION REACTION

Salts can be made by reacting an acid with an alkali. The reaction between an acid and an alkali is called neutralisation. In this reaction, the products are salt and water. For example: when hydrochloric acid is treated with sodium hydroxide following reaction occurs.

$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(s)} + H_2O_{(l)}$$

Indicators

The compounds that are used to identify acids and alkalies are called indicators.

Table: Some Common Indicators

Indicator	Colour in acid	Colour in Alkali
Litmus	Red	Blue
Methyl orange	Red	Yellow
Phenolphthalein	Colourless	Pink

DO YOU KNOW?

Phenolphthalein is an indicator, which has pink colour in an alkali and is colourless in an acid. It is used to indicate end point of a neutralisation reaction.

Activity 7.3 Neutralization reaction

To be demonstrated by the teacher only because sodium hydroxide is very corrosive.

Materials required

- Burette, pipette, burette stand, beakers, conical flask.
- Solutions of hydrochloric acid and sodium hydroxide and phenolphthalein.

Procedure

- Fit up burette vertically in the burette stand.
- Fill burette with HCl solution upto zero mark.
- Transfer 25cm^3 of NaOH solution in the conical flask with the help of pipette.
- Add few drops of phenolphthalein in it.
- Record your observation.
- Run the HCl solution in the conical flask drop by drop and shake the flask constantly.
- Go on adding the acid solution till the pink colour just disappears. This is end point of neutralisation.

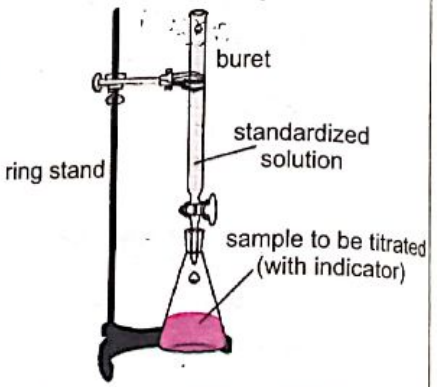


Figure 7.5 Acid base Titration

Following reaction takes place.

$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

Note: Acids and bases are corrosive so handle them with care and under the guidance of your teacher.

Teaching Point: Teacher may give more examples of neutralization reactions. Also explain precautions in this activity.

What are the two products of neutralisation reaction between potassium hydroxide (KOH) and hydrochloric acid?

Write a chemical equation for this reaction.

Importance of neutralisation reactions

Do we experience neutralisation reactions in our daily life?

Indigestion:

Our stomach produces hydrochloric acid, which helps in digestion. Sometimes stomach produces excess of hydrochloric acid. This causes burning in stomach called indigestion.

UNIT 7 ACIDS, BASES AND SALTS

Antacids contains alkalies such as magnesium hydroxide also known as milk of magnesia. During indigestion, taking milk of magnesia gives relief, since it neutralise the effect of excess acid.

Figure 7.6 Indigestion

Figure 7.7 Wasp

Wasp sting

When a wasp sting you, it injects an alkali in your skin. This causes burning, pain and swelling on your skin. You can neutralise its effects by rubbing an acid like vinegar on it.

Ant or Bee sting

When an ant or a bee stings you, it injects an acid under your skin. You can neutralise it by rubbing baking soda or calcium hydroxide on it.

Figure 7.8 Ant

Figure 7.9 Power station

Industries

The power stations and industries emit acidic gases such as sulphur dioxide and nitrogen dioxide. These gases are harmful for our body if inhaled. These gases are treated with an alkali, calcium oxide to neutralise and reduce their harmful effects.

Tooth Decay

Bacteria decay food particles in our teeth and produce acid. This acid causes tooth decay. Toothpaste contain an alkali so brushing tooth paste neutralises acid and prevent tooth decay.

Figure 7.10 Tooth decay

7.5 pH SCALE AND ITS RANGE WITH REFERENCE TO INDICATOR

Figure 7.11 pH paper

All the aqueous solutions are either acidic, alkaline or neutral. A number scale that runs from zero to 14, is used to measure how acidic or alkaline a solution is. This scale is known as pH scale.

A numerical value that indicates the strength of an acidic or alkaline solution is called pH.

- The solutions of acids have pH less than 7.
- The solutions of alkalies have pH greater than 7.
- The neutral substances such as water have pH of 7.

pH Paper or Universal indicator contains mixture of different indicators. It changes colour according to pH of solution. Figure 7.12 shows the colour of pH paper at different pH values.

Besides universal indicator, litmus and phenolphthalein are also most commonly used indicators. These indicators change colour over a certain pH range. For example litmus range pH 4.5 to 8.32 and changes colour from red to blue.

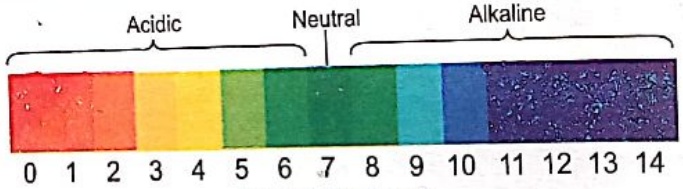


Figure 7.12 pH scale

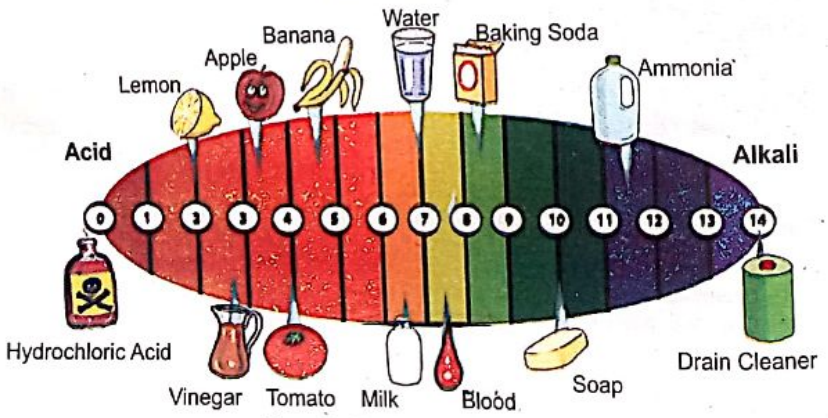


Figure 7.13 pH of common materials

Activity 7.4 Determining pH

Materials required:

- pH paper
- Solutions of strong acids such as HCl, H_2SO_4
- Solutions of strong alkalies such as NaOH, KOH
- Sugar solution, distilled water, beakers.

Procedure:

- Place solutions of acids, alkalies, sugar and distilled water in separate beakers.
- Dip a piece of pH paper in each beaker.
- Record your observation in the following table:

Substance	Colour developed on pH paper	pH Value
HCl		
H_2SO_4		
NaOH		
KOH		
Sugar		
Distilled water		

Caution: Handle Acids and alkalies under the guidance of your teacher.

Conclusion

- Colour of pH paper in strong acids marks the start of pH scale at 0 to 1.
- Colour of pH paper in strong alkalies marks the end of pH scale at 14.
- Whereas colour of pH paper in sugar solution or distilled water marks the middle of pH scale at 7.

Key Points

- An acid is a substance that dissolves in water to produce hydrogen ions (H^+).
- An alkali is a substance that dissolves in water to produce hydroxide ions (OH^-).
- Indicators are substances that change colour if they are put into an acid or alkaline solution.
- Acids turn blue litmus paper red.
- Alkalies turn red litmus paper blue.
- The pH scale gives a numerical value to show how acidic or alkaline a solution is:
  - Acids have pH less than 7.
  - Alkalies have pH greater than 7.
  - A neutral solution has pH equal to 7.
- When an acid reacts with an alkali, it forms salt and water. This type of reaction is known as neutralisation reaction.
- Antacids are compounds that neutralise excess acid in our stomach, when suffering from indigestion.

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. Which of the following pH value denotes acid?
   a. 11 b. 8 c. 3 d. 7
2. Which acid is present in vinegar?
   a. HCl b. HNO_3 c. CH_3COOH d. H_2CO_3
3. A solution is strongly acidic, if its pH is:
   a. greater than 7 b. 7 c. 1 d. 14
4. When dissolved in water, acids give?
   a. OH^- b. Cl^- c. H^+ d. Na^+
5. Which of the following is not an alkali?
   a. KOH b. $NaOH$ c. H_2CO_3 d. $Ca(OH)_2$
6. Which of the following is salt?
   a. $NaOH$ b. HCl c. $NaCl$ d. HNO_3
7. Which acid is used in car battery?
   a. HCl b. HNO_3 c. CH_3COOH d. H_2SO_4

UNIT 7 ACIDS, BASES AND SALTS

8. When an ant or a bee stings you, it injects
   a. an alkali. b. an acid. c. a salt. d. water.
9. Which of the following is **NOT** a mineral acid?
   a. Hydrochloric acid b. Sulphuric acid c. Acetic acid d. Nitric acid
10. Acids react with carbonates to liberate
    a. hydrogen. b. oxygen. c. carbon dioxide. d. ammonia.

B. Short questions

a) You cannot neutralise the effects of wasp sting with calcium hydroxide. Give Reason.
b) You can neutralise the effects of bee sting with calcium hydroxide. Give Reason.
c) Antacids are used to treat indigestion. Justify.
d) Which acid and base would you use to make potassium chloride?
e) Toothpastes are made slightly alkaline. Justify.
f) Which of the following solutions will have pH more than 7
   i) Milk of magnesia ii) Drain cleaner iii) Vinegar

C. Long questions

a) Describe acids and bases with at least three examples.
b) Differentiate between strong and weak acids with examples.
c) Give examples of strong and weak bases.

D. Structured response questions

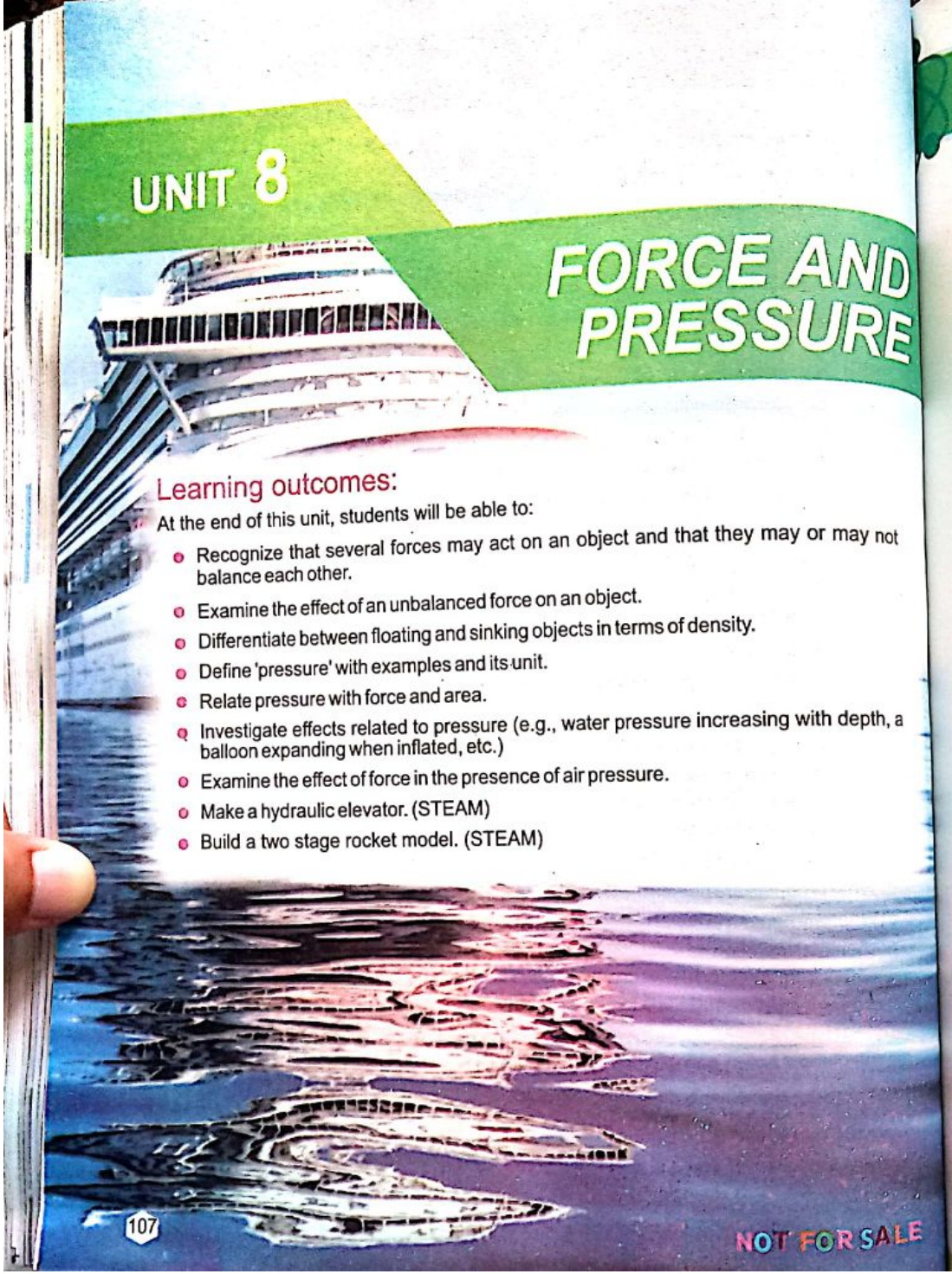
1. In an experiment, a student is adding hydrochloric acid to sodium hydroxide solution, until the pH of the mixture changes to 7
   a) How can he find out if the pH of the mixture changed to 7?
   b) Is the mixture acidic, alkaline or neutral when pH is 7?
   c) What products are present in the beaker, when pH changes to 7?
   d) What will happen to the pH, if more or excess hydrochloric acids is added?
2. A chemical reaction is occurring between two substances in a beaker. Temperature changes from 25°C to 50°C in the beaker and pH changes to 7.
   a) Is the reaction exothermic? Explain your answer.
   b) What type of chemical reaction has occurred in the beaker?
   c) What type of reactants are present in the beaker?
   d) What could be the final products in the reaction?

E. Project work

Search and prepare report about the acids used in jams, jellies, tomato ketchup, pickles and toilet cleaners.

UNIT 8

FORCE AND PRESSURE



Learning outcomes:

At the end of this unit, students will be able to:

- Recognize that several forces may act on an object and that they may or may not balance each other.
- Examine the effect of an unbalanced force on an object.
- Differentiate between floating and sinking objects in terms of density.
- Define 'pressure' with examples and its unit.
- Relate pressure with force and area.
- Investigate effects related to pressure (e.g., water pressure increasing with depth, a balloon expanding when inflated, etc.)
- Examine the effect of force in the presence of air pressure.
- Make a hydraulic elevator. (STEAM)
- Build a two stage rocket model. (STEAM)

Can we see forces acting on the object? When we push a door, the door receives a push from us. A force is a push or pull exerted on an object.

To fully explain force, we do not only need the strength of the force but the direction in which the force is acting.

For example, for a book lying on table it is intuitive to pull it up to lift it. If we push it downwards it just stays fixed.

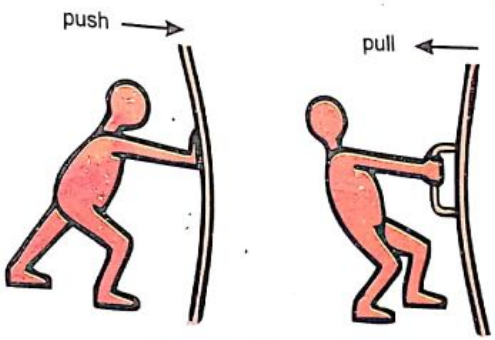


Figure 8.1 Force is push or pull

As in the figure 8.1 push and pull are represented by different force directions. Forces can cause objects to speed up, slow down, or change direction as they move. In System International (SI) the unit of force is **newton** and is represented by symbol **N**.

8.1 MULTIPLE FORCES

Sometimes more than one force can act on an object. For example, the figure 8.2 shows a book lying on table. What are the forces acting on the book?

To study the effects of forces acting on any object, we can apply the skill of drawing force diagrams. In force diagrams the object on which forces are shown is reduced to a dot at its center and the forces acting on the object are represented by arrows pointing away from it.

In the force diagram, we see that the weight of the book is pushing the table down the book does not move. Why?

Because there is another force of table (reaction force) which is balancing this force by pushing up on the book.

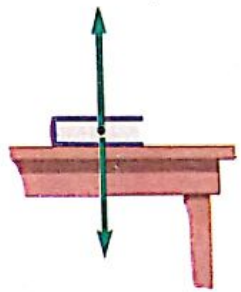


Figure 8.2 Book lying on table

8.2 NET FORCE

When all of the forces acting on an object are added together, we determine the net force on the object. Net force is the combined effect of all the forces acting on an object.

Knowing the net force on an object let us determine its effect on the motion of the object. Why? The net force tells us whether the forces on the object are balanced or unbalanced.

A. BALANCED FORCES

When the forces on an object produce a net force of 0 N, the forces are balanced. There is no change in the motion of the object. For example, a light bulb hanging from the ceiling does not move as shown in figure 8.3. This is because the force of gravity pulls down on the light while the cord pulls upward with same force. When the forces on an object are balanced, the object does not move.

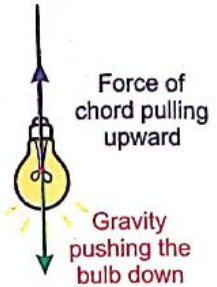


Figure 8.3 - Bulb hanging from chord

B. UNBALANCED FORCES

When the net force on an object is not 0 N, the forces on the object are unbalanced. Unbalanced forces produce a change in motion of an object. For example in a golf game, when the ball rest on the tee. When player hit the ball an unbalanced force is generated. It sends the ball with some speed in a certain direction determined by this unbalanced force.

An object can continue to move when the unbalanced forces are removed. For example, when golf ball is hit as shown in figure 8.4, it receives an unbalanced force. The ball continues to move until some other unbalanced force changes its motion (just like air resistance).

Figure 8.4 - Golf stick hitting a golf ball

UNIT 8 FORCE AND PRESSURE

An unbalanced force acting on a still object could make the object start moving. An unbalanced force acting on a moving object could make the object change direction, change speed, or stop moving.

8.3 PRESSURE

Have you ever wondered why a blunt knife cannot cut meat if the same force or even greater force is applied as compared to a sharp knife.

In this case we have to consider not only the force but also the area on which it acts. In case of blunt knife the force distributes over larger area and so we say the pressure is less. When a sharp knife is used the force concentrate on smaller area we say pressure is high. It is high pressure that enables us to cut meat easily with sharp knife.

The force acting on a unit area of a surface is called pressure.

Figure 8.5 Sharp knife cut meat easily

$$\text{Pressure} = \frac{\text{Force}}{\text{Area on which force acts}}$$

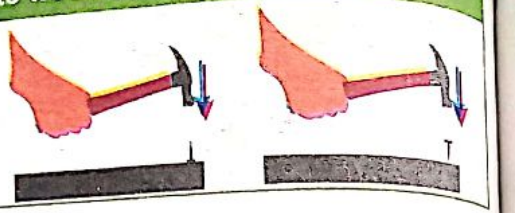
Note that the area is in the denominator in the above expression. So, the smaller the area, larger the pressure on a surface for the same force. Therefore, it is easier to drive a pencil into sand, compared to press down the book lying flat in the same sand. In case of pencil the force is concentrated on the small area, whereas in case of book the force is distributed over large area.

STOP AND CHECK

Assuming same force is applied at both ends of this thumb-pin, On which side is the pressure greater?

Activity 8.1 Pushing the nail into wood

Try to push a nail into a wooden plank by its head. Did you succeed? Try now to push the nail by the pointed end. Could you do it this time? Why?



UNIT OF PRESSURE

The SI unit of pressure is pascal (Pa). One pascal is equivalent to one newton (1 N) of force applied over an area of one meter square (1 m^2).

Do liquids and gases also exert pressure? Does it also depend on the area on which the force acts?

Pressure in liquids and gases is determined by the flow of mass from a high pressure region to a low pressure region.

Pressure in a liquid increases with depth. Drill three holes from the top to bottom of a long container. Now fill the container with water. The water spurts out slowest and closest from the top hole while it spurts out fastest and furthest from the lowest hole as shown in figure 8.6. This shows that the further down you go, the greater the weight of liquid above, hence more pressure is exerted.

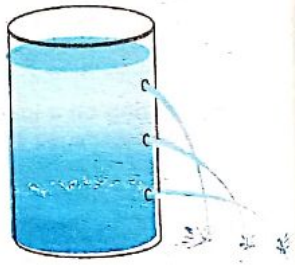


Figure 8.6 Pressure in a liquid increases with depth

Pressure at one depth in liquids acts equally in all directions. Drill four holes at the same height from the bottom of a can. Now fill the can with water. Water comes out equally fast and spurts equally far from each hole as shown in figure 8.7. Hence the pressure exerted by the water at this depth is the same in all directions.

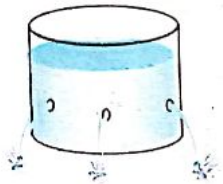


Figure 8.7 Pressure in a liquid at one depth act equally in all directions

Teaching Point: Make students aware of the International System Of Units (SI) as a standard for measurements that is used all around the world.

UNIT 8 FORCE AND PRESSURE

Pressure depends on the density of the liquid. Density is a measure of how closely packed the particles in a substance are. It is a ratio of the mass of an object to its volume. The denser the liquid, the greater the pressure at any given depth.

Gases can exert pressure, the pressure of a gas is the force that the gas exerts on the walls of its container. For example the pressure in air (gas) can be used to inflate tyres because the pressure of air molecules is greater on the inside of the tyre than the outside. Atmosphere also exerts a pressure however we are so use to it that we usually ignore it.

DO YOU KNOW?

The atmosphere is the layer of gases that surrounds Earth. The atmospheric air extends up to many kilometres above the surface of the earth. Atmospheric pressure is the pressure within the atmosphere of Earth. Atmospheric pressure varies with height just as water pressure varies with depth. As a swimmer dives deeper, the water pressure increases. As a mountain climber ascends to higher altitudes, the atmospheric pressure decreases.

The atmospheric pressure at 20,000 feet is only one-half of that at sea level because about half of the entire atmosphere is below this elevation. The standard atmosphere (symbol: atm) is a unit of atmospheric pressure and is equivalent to 101325 Pa

(1atm = 101325 Pa).

Blowing up a balloon involves forcing additional air particles from your lungs into the balloon. These particles hit the inside walls of the balloon creating enough pressure to force the rubber of the balloon to expand and the balloon to inflate. The collision of these particles with the walls creates a higher-pressure than atmospheric pressure around it, to keep it inflated as shown in figure 8.8.

After inflating a balloon, why do we have to close its mouth? What happens if we open the mouth of an inflated balloon? Can we say that air exerts pressure in all directions?

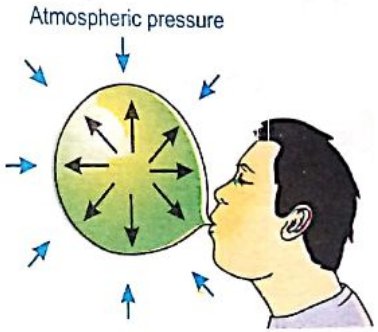


Figure 8.8 Expanding a balloon

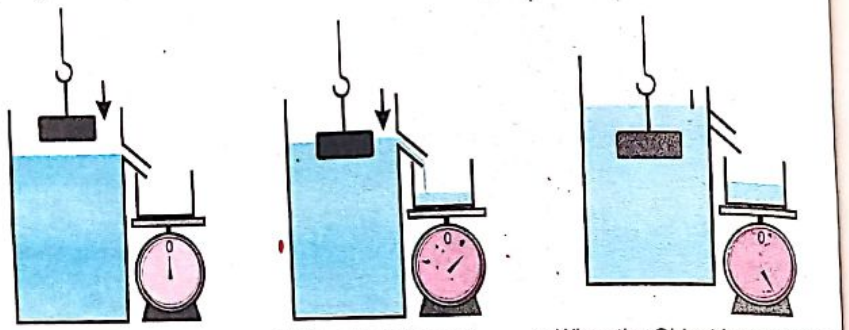
8.4 BUOYANCY

If you try to push a piece of cork underwater, you feel that the cork pushes back up. This is because a fluid exerts an upward force on objects that are partially or completely submerged in it. This upward force is called buoyant force and phenomena is called buoyancy.

Consider an object is lowered in water as shown in figure 8.9. An opening on the side of the container at the water's surface allows water to flow out of it.

As the object sinks, the water level rises and water flows into a smaller container. The displaced volume of water is equal to the volume of the portion of the object that is underwater.

The weight of this displaced water equals the buoyant force acting on the object.



a. An object is being lowered into a container of water.

b. The object displaces water, causing the water to flow into a smaller container.

c. When the Object is completely submerged, the volume of the displaced water is equal to object's volume.

Figure 8.9 The weight of this displaced water equals the buoyant force acting on the object.

POINT TO PONDER

Why balloon bursts when pricked with pin?

When you inflate a balloon, the air pressure inside it is much more than the atmospheric pressure outside it. If the balloon is pricked, all the air tries to come out with great force. This small hole cannot allow so much of air to go out at once. Also, now that there is weak spot in the membrane, the pressure due to the air tears apart the rubber in an instant.

UNIT 8 FORCE AND PRESSURE

Buoyant force arises because pressure increases with depth in a fluid. This means that the upward force on the bottom of an object in a fluid is greater than the downward force on the top of the object. There is a net upward, or buoyant force on any object in any fluid. If the buoyant force is greater than the object's weight, the object will rise to the surface and float. If the buoyant force is less than the object's weight, the object will sink. If the buoyant force equals the object's weight, the object will remain suspended at that depth.

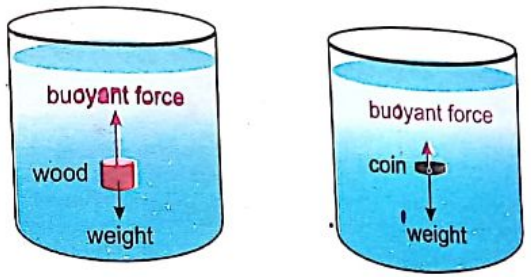


Figure 8.10 Buoyant force on wood and coin

The buoyant force is always present whether the object floats, sinks or is suspended in a fluid. For example if we push a wood block under water the buoyant force equals the weight of water displaced; since water is denser than wood, the buoyant force is greater than the wood's weight, and that's why wood floats. Now when we submerge a coin, since it is denser than water, so the coin's weight is greater than the weight of the displaced water and it sinks as shown in figure 8.10.

POINT TO PONDER

Steel is almost eight times denser than water. Yet huge steel ships doesn't sink. If steel is more dense than water, how can these ships float? The reason a steel ship floats is because of its shape. If the ship were just a big block of steel, it would sink very quickly. However, ships are built with a hollow shape. The hollow shape increases the volume that the steel takes up without increasing the mass of the steel.

8.5 HYDRAULIC ELEVATOR

An elevator or lift is a vertical transport vehicle that efficiently moves people or goods between floors of a building. They are generally powered by electric motors that either drive traction cables and counterweight systems, or pump hydraulic fluid to raise a cylindrical piston.

If the pressure in a fluid is increased at any point in a container (such as at the valve of the tire), the pressure increases at all points inside the container by exactly the same amount. The same principle is at work in hydraulic elevator or lift.

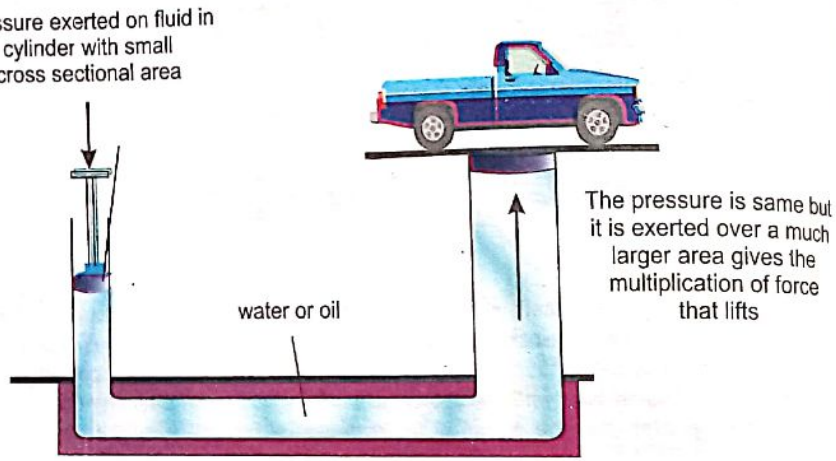


Figure 8.11 Hydraulic elevator or lift

Two cylinders one with smaller cross sectional area and the other with larger cross sectional area are shown in Figure 8.11. The cylinders, each of which is fitted with a piston, are connected by a tube and filled with fluid (water or oil).

When the pressure on fluid in cylinder with small cross sectional area is exerted, this pressure is equally distributed in all parts of water (or oil). Although the pressure is same, but at the other end it is distributed over the larger area, which multiplies the force. Thus, force in small cylinder exerted over the large distance is traded for large force exerted over small distance. This small effort is used to lift a larger weight.

Teaching Point: Make it clear to students that hydraulic lift does not violate conservation of energy. The pressure is same at either end of the pipe therefore the same amount of work is being done.

Activity 8.2 How to make a hydraulic elevator

Material required:

- 10 ml syringe
- 20 ml syringe
- Connecting tube of sufficient lengths to connect the syringes
- Glue (Glue gun)
- Wall plate to work as elevator
- Few loads (toy car)

Procedure

- Glue the wall plate to the flat the top of 20 ml syringe.
- Connect the 10 ml syringe with connecting tube fill both tube and syringe from water (colour may be added to make it look beautiful). Push the syringe to remove any air from the tube.
- Mount the 20 ml syringe with wall plate on stand and clamp it tightly.
- Connect the free end of the tube attached to 10 ml syringe with 20 ml syringe.
- The hydraulic lift is ready, put some object on the platform and try lifting it.

Did the object go up easily?

Did you need to push hard?

Try lifting some heavier objects. How much mass can you lift?

Extensions Repeat the experiment by interchanging syringes.

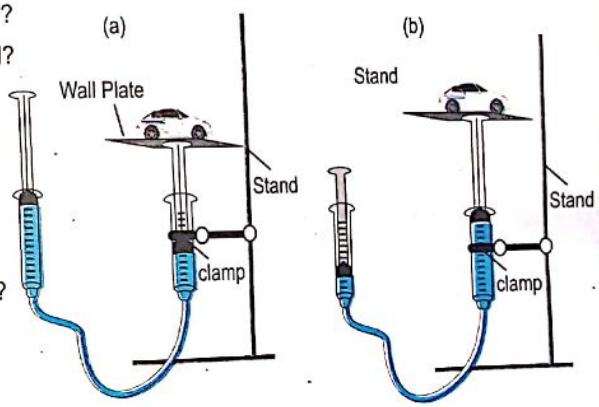
Can you lift object higher?

Do you have to push hard?

Can you lift heavier objects? How much mass can you lift?

Why is the difference?

Repeat the experiment by changing water with oil. Now what are the changes?



Syringe hydraulic elevator model

8.6 ROCKET

Rockets carry fuel that is burned inside a chamber. The fuel burns when it is mixed with oxygen gas and ignited, or set on fire. As the fuel burns, it releases hot gas that shoots out from an opening at the back of the chamber. The force of the gas moving backward pushes the rocket forward.

The pressure bottle rocket works according to Newton's 3rd law of motion. As you pump up your rocket with air, pressure builds up inside. Eventually, this pressure pushes the rocket off of the cork and bicycle pump, and expels the water in the bottle downward — this is the action. The reaction to this downward movement of the water is the rocket's own upwards movement, sending it high into the sky.

Figure 8.12 Rocket

Activity 8.3 Building a water pressure rocket

Materials:

- empty (2 liter) plastic bottle
- cardboard made into a cone and 4 fins
- a cork
- a pump with a needle adaptor
- water
- some glue and colour cards for beautification of rocket.

Procedure

Drill a small hole through the center of your cork stopper. The hole should be just smaller than the diameter of your pump needle.

Push the needle adaptor of the pump through the cork, it needs to go all the way through so you might have to trim the cork a little bit.

Fit the cork into bottle opening. If it is not fitting just tape it around until it fits.

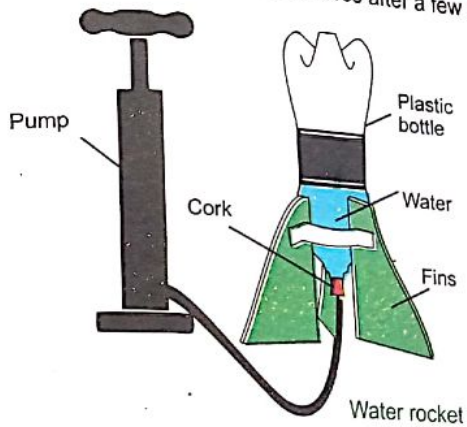
Decorate the bottle with the cone and fins.

Fill the bottle one quarter full of water and push the cork in tightly.

Take the bottle outside and connect the pump to the needle adaptor.

Activity 8.3 Cont...

Pump air into the bottle, the bottle will lift off with force after a few seconds.



Water rocket model

Precautions

When launching rockets, it is important for the other students to stand back. Countdowns help everybody to know when the rocket will lift off.

Once pumping get started let no one to not approach the rocket, even if it appears that nothing is happening, as this can lead to injury.

Did it work? How high did it rise?

How does air pressure make a rocket move up?

Extensions

A two-stage rocket launch rocket has two distinct stages provide propulsion one after the other. Rather than building a single, huge rocket that goes all the way into orbit, scientists and engineers have developed multistage rockets. When the first stage is done burning its fuel, it breaks away and falls back to Earth. This allows the smaller, lighter second stage of the rocket to keep going, without carrying the weight of the first stage.

Can you make this rocket into two stage rocket? try it.

Teaching Point: According to Newton's third law of motion all the forces acts in pairs. When one object exerts a force on other object, the other object also exerts an equal but opposite force on the first object.

Key Points

- A force is a push or pull exerted on an object. Forces can cause objects to speed up, slow down, or change direction as they move.
- Net force is the combined effect of all the forces acting on an object.
- When the forces on an object produce a net force of 0 N, the forces are balanced.
- When the net force on an object is not 0 N, the forces on the object are unbalanced. Unbalanced forces produce a change in motion of an object.
- All forces act in pairs. Whenever one object exerts a force on a second object, the second object exerts a force on the first object.
- The force acting on a unit area of a surface is called pressure.
- Liquid pressure increases with depth, it acts equally in all directions and depends upon the density of the liquid.
- Buoyancy or upthrust, is an upward force exerted by a fluid that opposes the weight of an immersed object.
- Friction is the resistance to motion of one object moving relative to another.
- Hydraulic elevators use the principle of hydraulics to pressurize piston to raise and lower the load (such as car).

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. A football is at rest on ground the forces acting on it are
   a. zero. b. balanced. c. unbalanced. d. uncountable.
2. An object is moving in a circle uniformly the forces acting on it are
   a. zero. b. balanced. c. unbalanced. d. uncountable.
3. The unit of buoyant force is
   a. pascal. b. newton. c. buoyancy. d. pressure.
4. Which of the following quantities is measured in units of pascal?
   a. Friction b. Buoyancy c. Pressure d. Force
5. Force applied per unit area gives
   a. buoyancy. b. pressure. c. friction. d. net force.
6. With depth, pressure in a liquid
   a. decreases. b. increases. c. stay the same. d. is zero.
7. The atmospheric pressure will be lowest
   a. in Islamabad. b. in Lahore. c. in Karachi. d. on top of K2.

8. A toy floats in a bathtub. The buoyant force exerted on the toy depends on the volume of
   a. water in the bathtub. b. the bathtub.
   c. the water displaced. d. the toy under water.
9. If a submerged object displaces an amount of liquid with a weight less than its own, when the object is released, it will
   a. sink. b. remain submerged in equilibrium.
   c. float. d. pop up out of the surface.
10. If the same-sized force is made to act over a smaller area
    a. the pressure is decreased. b. the pressure is not changed.
    c. the pressure is increased. d. the result depends on the shape of the area.

B. Short questions

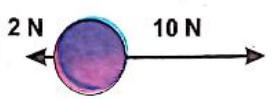
1. If there are many forces acting on an object, how can the net force be ZERO?
2. Why stepping of high heeled shoe hurts more than a flat shoe?
3. Explain why objects moving in fluids must have special shapes.
4. Consider two identical pails of water filled to the brim. One pail contains only water, the other has a piece of wood floating in it. Which pail has the greater weight?
5. Why does the fish float in the middle of the water?
6. Why is atmospheric pressure greatest at the surface of Earth?

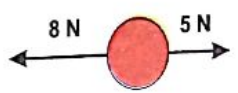
C. Long questions

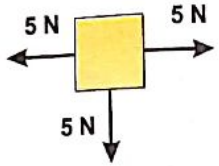
1. What is net force? How it affect the motion of an object?
2. How is pressure related to force and area?
3. What is buoyancy? What determines the object to sink or float?

D. Constructed response questions

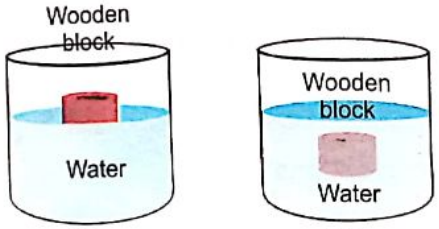
1. Determine the net force on each of the objects shown below. Don't forget to give the direction of the force.







2. A block of wood is floating on the surface of water as shown in figure (a). In Figure (b), the same block of wood is pushed beneath the surface of the water. What will happen to the wood when the downward force in Figure (b) is removed? Also draw the buoyant force in the figure.



(a) (b)

3. The pressure inside the lungs increases and decreases with each breath. When we inhale and exhale when is the pressure in the lungs greater than atmospheric pressure and when is it lower than atmospheric pressure?

(a) Inhalation (b) Expiration

4. A submarine is a type of ship that can travel both on the surface of the water and underwater. How submarine is able to both float and sink?

E. Project work

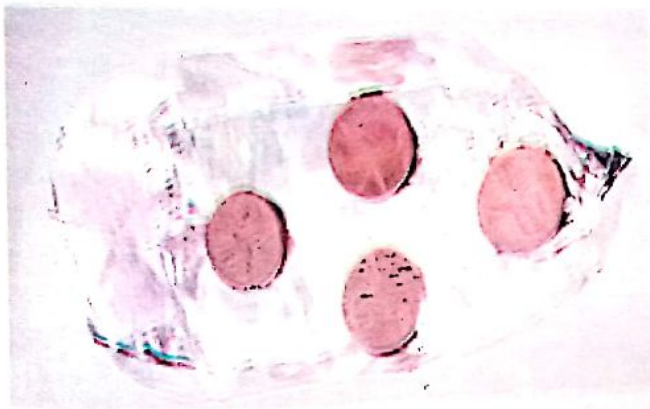
Making a boat from Aluminum foil

Why does a rock sink in water while a gigantic steel aircraft carrier floats?

MATERIALS: Aluminum foil, Bath tub or sink full of water (wide enough for the "boat" to float and deep enough to have it completely submerged), scissors, and Scotch tape.

PROCEDURE: The following procedure steps are followed

1. Try to shape aluminum foil in different types of boats with the help tape and scissors.
2. You can fold or even cut the aluminum foil if you wish to obtain the desired shape.
3. Make finishing touches to the boat hulls so that they are ready to test
   - Make sure there are no leaks.
   - Make sure the hulls seem to hold their shape. If they do not, try adding a little tape to make them stronger.
   - Flatten the bottoms of the hulls.
   - Try to make sure each hull's rim is the same height going all around the edge of the hull. In other words, make sure there is not a low point in the rim of any of the hulls.
4. Measure the buoyancy of your boat.
   - Weigh a single coin.
   - Carefully float one of the hulls in the container of water.
   - Gently add one coin at a time. To prevent the hull from tipping, carefully balance the load as you add coins .
   - Keep adding coins until the boat finally sinks.
   - The number of coins the ship supported multiplied by weight will give you buoyancy of your boat.



UNIT 9

REFLECTION AND REFRACTION OF LIGHT

Learning outcomes:

At the end of this unit, students will be able to:

- Identify basic properties of light (i.e., speed, transmission through different media, absorption, reflection and dispersion).
- Describe and show how an image is formed by the plane mirror.
- State the Laws of Reflection.
- Describe different optical instruments which use curved mirrors.
- Relate the apparent color of objects to reflected or absorbed light.
- Explain that light is refracted at the boundary between air and any transparent material.
- Distinguish between reflection and refraction of light with daily life examples.
- Illustrate the characteristics of image formed by plane mirror.
- Investigate that light is made up of many colours.
- Relate the apparent color of objects to reflected or absorbed light.
- Identify spherical mirror, describe the characteristics of image(s) formed by concave mirrors and convex mirrors.
- Describe use of different optical instruments with plane in which spherical mirrors are used.

Why we can't see objects in the dark? And why these objects are visible in light?

We see object when light enters into our eyes. Light emitted from luminous objects (such as light bulb or sun) enters directly into our eyes making them visible, while for non-luminus objects (such as table or chair) to be visible the light need to be reflected into our eyes to make them visible as shown in figure 9.1.

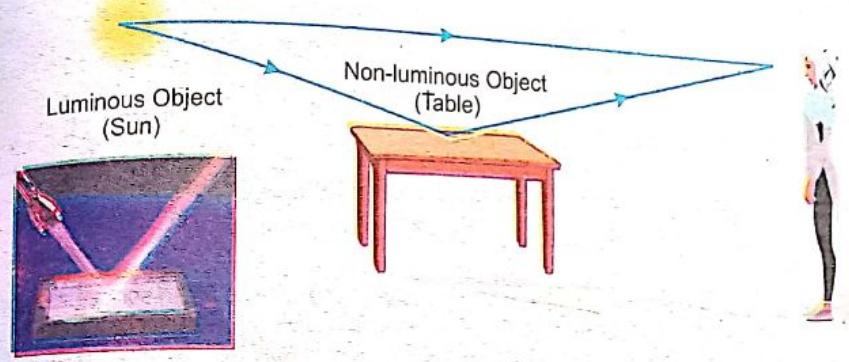


Figure 9.1 Mechanism of how we see objects

9.1 PROPERTIES OF LIGHT

Interaction of Light with Matter

When light hits an object, it can be transmitted, absorbed or reflected.

A. **Transmission of light**: When light interact with matter it can **pass through a substance** as shown in figure 9.2 (a). Transmission of light makes an object to appear transparent or translucent.

- **Transparent** – visible light is transmitted easily and objects are seen clearly behind it (for example glass).
- **Translucent** – some visible light is transmitted, but some is scattered so that objects are not clearly seen behind it (for example frosted glass or some plastics).

B. **Absorption of Light:** When light interact with matter it can be absorbed, the energy in the light waves is converted into other forms of energy such as thermal energy as shown in figure 9.2 (b). The objects appear opaque because of absorption of light. Dark or black objects absorb more light and feel hotter than lighter or white objects.

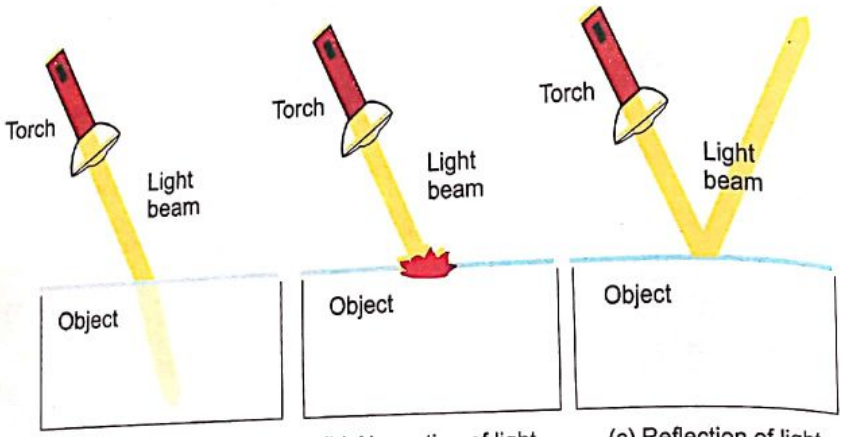


Figure 9.2 Interaction of light with matter

C. Reflection of light: When light interact with matter it can bounces off a surface as shown in figure 9.2 (c). Nearly all objects reflect some light to be visible. Highly polished surfaces such as mirrors are opaque because most of the visible light is reflected, none is transmitted and very little is absorbed.

Speed of Light

The speed of light is very fast. During a thunderstorm the flash of lightning is seen before we hear the roar of thunder. It appears like light travels instantly to us, but in fact speed of light has a definite value; and takes a certain, very small time to reach us.

DO YOU KNOW?

Only in one second light travels a distance about 300,000 kilometres ($3x10^8$m/s).

The Sun is 150 million kilometres away from earth and light reaches from sun in only 8 minutes and 20 seconds. The light reflected from the surface of the moon takes only in 1.3 seconds to reach Earth.

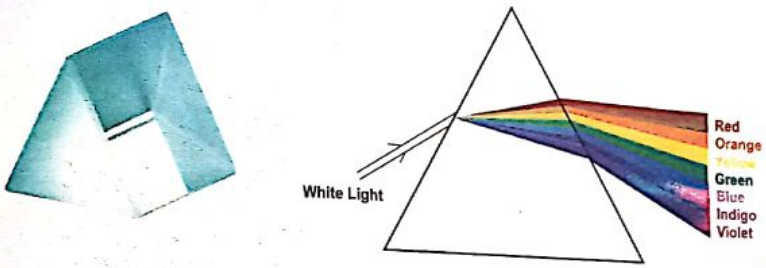
The speed of light is about 1 million times greater than that of sound.

Light moves at the fastest known speed in the universe. Nothing moves faster than (or even close to) the speed of light, therefore, the speed of light is very important value in science and is very accurately measured. Light also travels through transparent medium, such as air, water, and glass. When light passes through a medium, it travels slightly slower than it does in a vacuum.

UNIT 9 REFLECTION AND REFRACTION OF LIGHT

Dispersion

When sunlight (white light) falls on a triangular glass prism as in figure 9.3(a), a band of colours called a spectrum is obtained as illustrated in figure 9.3 (b). The effect is termed dispersion. It arises because white light is a mixture of many colours; the prism separates these colours. These are the colours of the rainbow, and there are seven distinct colors that blend one into one another. These colours are red, orange, yellow, green, blue, indigo and violet.



(a) PRISM (b) DISPERSION OF LIGHT

Figure 9.3 Dispersion of light through prism

9.2 RAY MODEL OF LIGHT

The direction of the path in which light is travelling is called a ray and is represented in diagrams by a straight line with an arrow on it. A beam is a stream of light and is shown by a number of rays in figure 9.4. A beam may be parallel, diverging (spreading out) or converging (getting narrower).

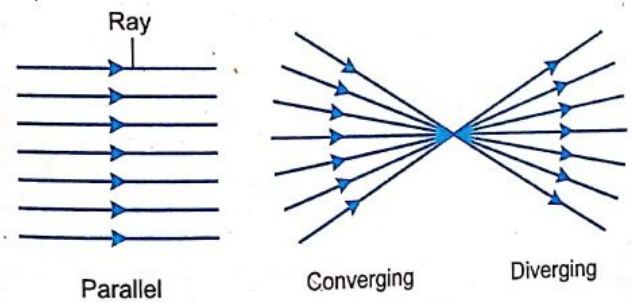


Figure 9.4 Beam of light

The Ray Model of Light assumes that **light travels in straight-line** paths called light rays. According to the ray model of light, when we see an object, light reaches our eyes from each point on the object.

Although light rays leave each point in different directions, only a small bundle of these rays enter the eye of an observer, as shown in Figure 9.5. If the person moves his head, a different bundle of rays will enter the eye.

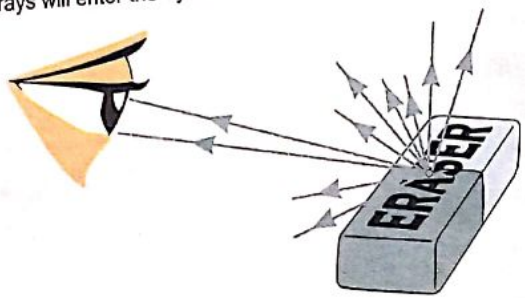


Figure 9.5 Light after being reflected from the eraser reaches our eyes from each point on it.

The method of following individual rays as they travel from an object to our eye or to some other point is called **ray tracing.**

Point to Ponder

We can see luminous objects from the light they emit, and we can see nonluminous objects from the light they reflect, but can we see the path of the light itself?

No light path cannot be seen directly, unless we make the light to interact with matter. For example, we cannot see a flashlight beam unless we fill the air with chalk dust or smoke. Sunbeams streaming through the windows of classroom or light from a cinema projector on its way to the screen both are visible because dust particles in the air reflect light into our eyes.

Teaching Point: Make students realize that the rays are only visual representation or the record of the path travelled by light, not a physical thing that can be bent or broken.

9.3 LAWS OF REFLECTION

The following terms are used describing the reflection of light.

a. The ray coming towards the surface is **Incident ray.**

b. The ray which bounce off the surface is **Reflected ray.**

c. **Point of incidence** is the point at which the incident ray strikes the reflecting surface.

d. **Normal** is the line drawn at right angles to the reflecting surface at the point of incidence.

e. **Angle of incidence** is the angle between the incident ray and the normal.

f. **Angle of reflection** is the angle between the reflected ray and the normal.

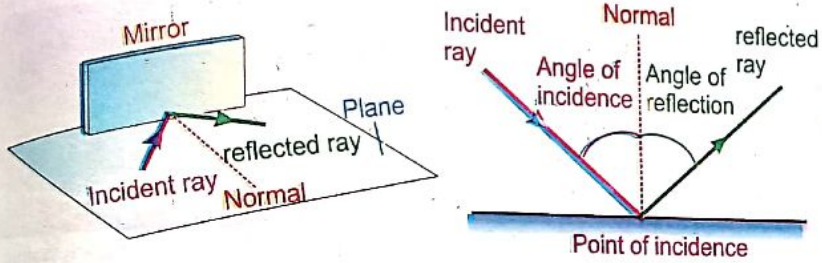


Figure 9.6 Laws of reflection

Laws of Reflection

Reflection is a change in direction that takes place when light strikes a surface and rebounds. The laws of reflection describes the behaviour of the incident and reflected rays.

- First Law: The incident ray, the reflected ray, and the normal to the surface all lie in the same plane.
- Second Law: The angle of reflection is equal to the angle of incidence.

Types of Reflection

There are two types of reflections

A. **Smooth surfaces reflect light rays in one direction:** When parallel light rays strike a smooth, plane surface, such as the ones in Figure 9.7 (a), the reflected rays are parallel to each other. This type of reflection is important in determining the properties of mirrors.

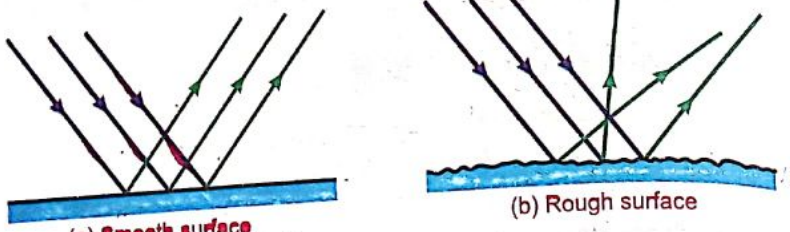


Figure 9.7 Types of Reflection

B. Diffuse reflection (Rough surfaces reflect light rays in many directions): Most surfaces, however, are not perfectly smooth, because they contain irregularities which are not visible to eye. The law of reflection applies to each ray, but the irregular surface reflects the light rays in various directions, as Figure 9.7 (b). Common surfaces like papers, wood and non-polished metals give diffused reflection.

DO YOU KNOW?

The Ancient Greek mathematician Euclid described the law of reflection in about 300 BC. This states that 'light travels in straight lines and reflects from a surface at the same angle at which it hits it'.

Figure 9.8 Leaf from a Walnut tree is not smooth under a powerful microscope

9.4 IMAGE FORMATION BY PLANE MIRROR

When we look into a plane (flat) mirror, we see an image of ourselves. How this image is formed? Why the image seems to originate from behind the mirror?

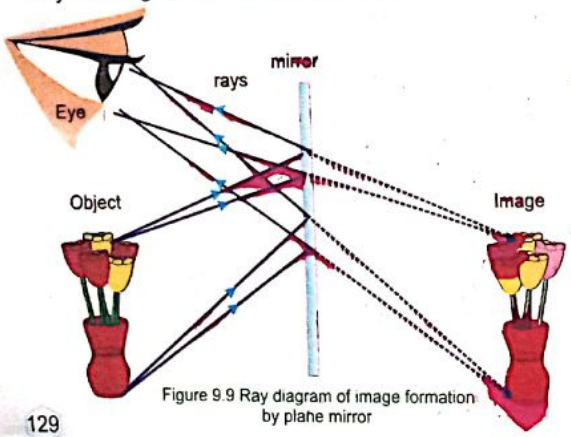


Figure 9.9 Ray diagram of image formation by plane mirror

Figure 9.9 shows two light rays leaving the top of an object. These rays reflect from the mirror (angle of reflection equals angle of incidence) and enters the eye. To the eye, it appears that the ray originates from behind the mirror, along the dashed lines. Similarly the figure also shows the behavior of two rays leaving the bottom of the object, therefore each point on an object, there is a single corresponding point on the image.

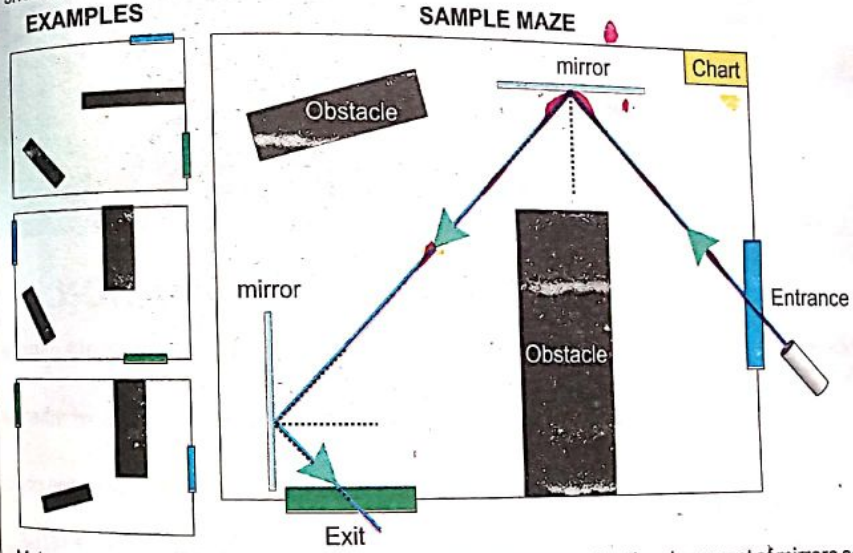
UNIT 9 REFLECTION AND REFRACTION OF LIGHT

All the rays that leave a given point on the object, no matter what angle they have when they strike the mirror, appear to originate from a corresponding point on the image behind the mirror.

Activity 9.1 Tracing mirror reflections

Materials: Small plane mirrors strips, small binder clips (attached to the bottom side edge of the mirror to hold the mirror erect), One ordinary laser light source, protractors and rulers (helps for drawing straight lines).

Procedure: Teacher will draw a series of obstacles on a piece of chart paper or can place actual obstacles for students to avoid. Teacher will also indicate an entrance and exit point and will make students predict where they should place mirrors so that the light beam successfully travels from the entrance to the exit. The examples and a sample maze is shown below.



Make students groups to use their new knowledge to determine the placement of mirrors so that a light beam can travel around obstacles in order to go from the entrance to the exit point in a "maze".

Once students have placed all their mirrors teacher will test their predictions with real obstacles and laser light to see how they did it.

Point to Ponder

The image on the mirror we see is not the same as how we appear to others. Figure (a) illustrates that our image in the mirror is reversed right to left and left to right. If we brush our teeth with our right hand, we see the left hand of the image doing brushing. Similarly, letters and words held up to a mirror are reversed. Ambulances and other emergency vehicles are often lettered in reverse, as in Figure (b), so that the letters will appear normal when seen in the back view mirror of a car.

9.5 CHARACTERISTICS OF IMAGE FORMATION

An image is a visual representation of an object which is placed somewhere in front of a mirror or lens. We can completely describe any image by defining four characteristics.

- The **magnification** is the ratio of the image size to the object size. It shows us whether the image larger, smaller or of the same size as object.
- The **attitude** of an image indicates whether the image is oriented the same way as the object (upright) or upside down (inverted) with respect to the object.
- The image **position** is the distance between the image and the optical device — such as mirror (or lens).
- The **type** of image, indicates whether the image is **real or virtual**.

Real Image

An image is real if light rays are actually converging at a point then continuing on beyond that point and diverging. In other words, if you place a screen at the image position, the image would appear on the screen.

9.5 CHARACTERISTICS OF IMAGE FORMATION

Virtual Image

If an image is not real, it is virtual, no light rays actually converge on the image position.

Our eyes can see both real and virtual images, as long as the diverging rays enter our pupils. For example a movie projector produces a real image that is visible on the screen, whereas mirrors produce virtual image.

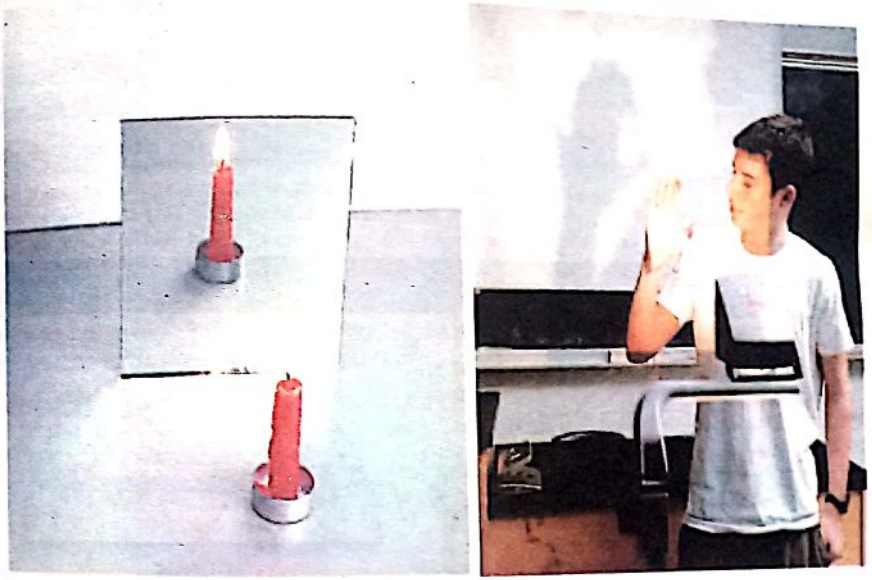


Figure 9.10 Virtual image is formed by candle and real Image is formed by light from overhead projector

Characteristics of Images in Plane Mirrors

For plane mirrors these characteristics are:

- **magnification:** the image is of the same size as the object.
- **position:** the image is at the same distance from the mirror as that of the object.
- **attitude:** the image is always upright, but is laterally inverted.
- **type:** the image is virtual.

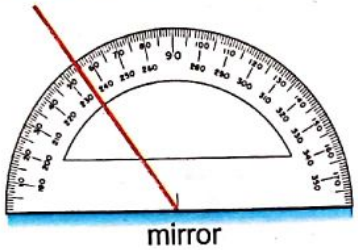
Table 9.1 - Characteristics of images in plane mirrors

Property or characteristic	Possible values	For plane mirror
Magnification	larger same size smaller	same size
Position	measured from optical device	same distance
Attitude	upright inverted	upright
Type	real virtual	virtual

Try it yourself

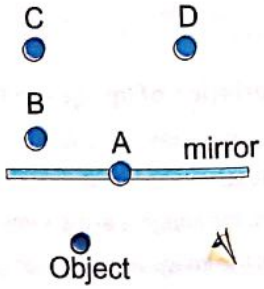
In figure a red beam of light is allowed to fall on the mirror, a protector is placed with the mirror. What is the angle of reflection in Degrees?

_____



In Figure a green dot is viewed through mirror, at which points (A, B, C or D) will the observer see the image in the plane mirror of the object?

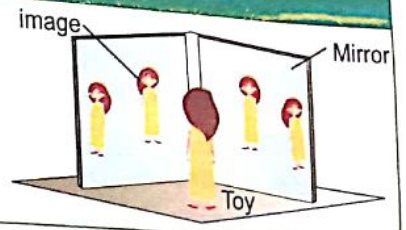
_____



UNIT 9 REFLECTION AND REFRACTION OF LIGHT

Activity 9.2 How many images

When two mirrors are mounted at right angles and taped together not only the two expected virtual images are formed, but an extra image is produced as well. Some of the light that enters the eye has been reflected twice, producing a third image.



DO YOU KNOW?

What is a periscope?

A periscope is an optical instrument that uses mirrors to reflect images through a tube. A periscope is an instrument to monitor over, around some obstacle or condition. The simplest type of periscope consists of a tube at the ends of which are two mirrors. The mirrors are placed at an angle of 45 degree, so that when light falls on one of the mirrors, then it gets reflected back making it fall on the other mirror.

The second mirror further gets reflected back to the observer's eyes. The longer or narrower the tube, the smaller the field of view.

Periscope have wide range of applications. Periscopes are used in the submarines to see what is going on the water surface. Similarly, these are in use on battlefields to look out of trenches safely without exposing the body of the observer. They are also used in tanks and other armed vehicles.

Figure 9.11 - Periscope and viewing mechanism

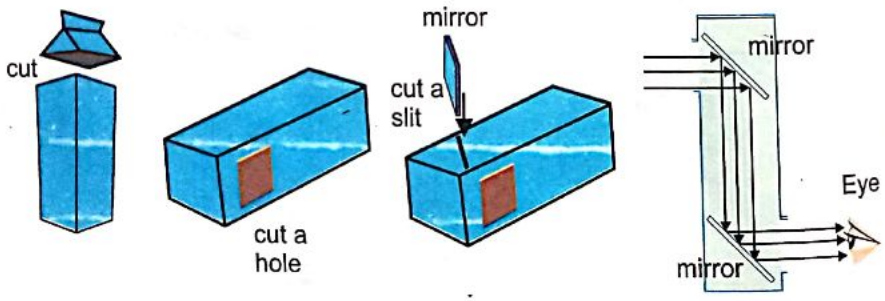
Activity 9.3 Making a periscope

MATERIALS

Two prepared cartons (empty rectangular cuboid juice or milk packaging can be also be used), two mirrors, scissors, tape and stickers/decorations.

PROCEDURE

- Carefully cut out the windows of the cartons.
- Measure and mark a 45° angle on the side of the box, extending from the bottom corner of the window up to the back of the box.
- Along this line, cut a slit into the cardboard.
- Insert the mirror into the slit
- Use a craft knife (an adult should do this part) to cut a slit along the 45° line. Make the cut as long as one side of the mirror. If the mirror is thick, widen the cut. Repeat with the second carton.
- Slide a mirror into the carton through the slit with the shiny side facing the window and the dull side facing the "roof."
- Repeat with the second carton.
- Tape the mirrors in place.
- Once the mirrors are firmly secured, join the two cartons together by sliding one into the other. Tape the two cartons together.



UNIT 9 REFLECTION AND REFRACTION OF LIGHT

9.6 COLOUR

Have you ever wondered, where do colours come from? The colour of the object or material is determined by the colours in light it absorbs and those it reflects. An object has a colour of light that it reflects. A red apple, absorbs most of the colours of light but reflects red, so the apple looks red, as shown in the figure 9.12.

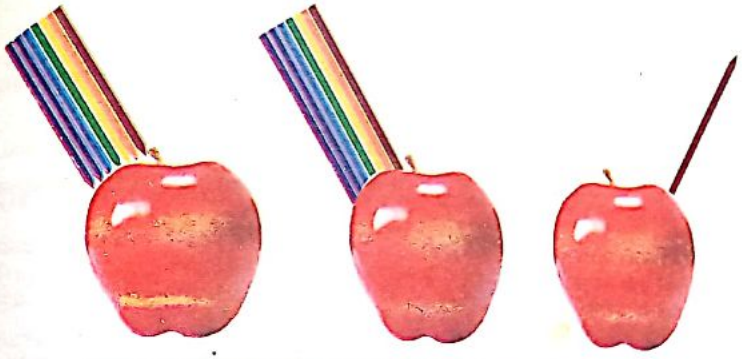


Figure 9.12 Reflection of light is what gives apple its red colour

A material that reflects all colours of light appears white. A material that absorbs all colours of light appears black.

However it must be noted that an object can reflect only those colours in the light that falls on it. For example if you make blue light fall on white piece of paper. The paper will appear blue (not white), because only blue light was available for it to reflect.

DO YOU KNOW?

If black is not a colour of the visible light, why some object still looks black?

When a person see the colour of an object to be black, he is actually seeing an object that has absorbed all the colours and has reflected almost none. This absence of colour is what human eye recognizes as black colour.

9.7 REFRACTION OF LIGHT

Although light travels in straight lines in a transparent material (such as air). However, if it passes from one material into another material it is bent at the boundary between them. For example, when light goes from air to water, the light bends. Refraction is the change of direction of light as it moves from one material (called medium) to another as shown in figure 9.13.

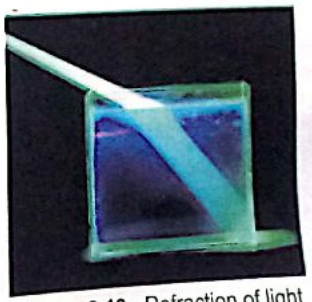


Figure 9.13 - Refraction of light

When light cannot pass through the material surface light rebounds after hitting that surface and the phenomena is termed as reflection of light. However when light hits a transparent medium (media through which light can pass such as glass, water, ice, quartz etc.) the light bends at the boundary and the phenomena is termed as refraction of light. In refraction the bending of light occurs due to change in the velocity of light. The speed of light in dissimilar materials is different, for example the speed of light in water is less than the speed of light in air, similarly the speed of light in glass is less than the speed of light in water.

The following terms are used describing the refraction of light

- **Incident ray** is the approaching ray of light towards a refracting surface.
- **Refracted ray** is the ray of light which bends after passing through from the refracting surface.
- **Point of incidence** is the point at which the incident ray strikes the refracting surface.
- **Normal** is a line drawn at right angles to the refracting surface at the point of incidence.

When light moves from a material in which its speed is higher to a material in which its speed is lower, such as from air to glass, the ray bent toward the normal, as shown in Figure 9.14 (a). If the ray moves from a material in which its speed is lower to one in which its speed is higher, as in Figure 9.14 (b), the ray is bent away from the normal. If the incident ray of light is parallel to the normal, then no refraction (bending) occurs in either case.

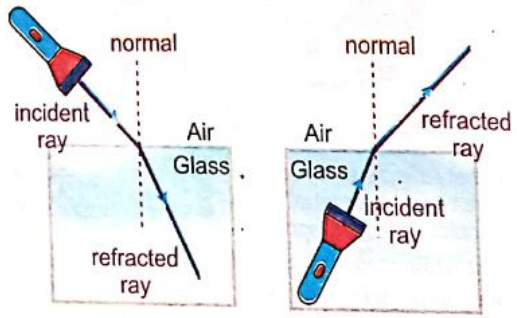


Figure 9.14 (a) A ray of light is bent towards the normal when it enters from air to glass. (b) A ray of light is bent away from the normal when it enters from glass to air.

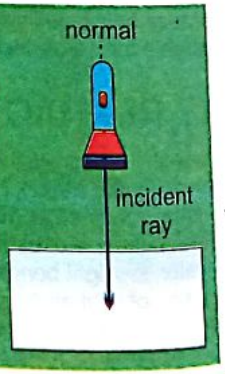
STOP AND CHECK

Why a ray of light beam while passing through plastic block appear shifted?

Point to Ponder

If ray of light falls on the surface of two media along the normal then in which direction the beam of light will bend?

A ray traveling along the normal direction at a boundary is not bent and pass straight into other medium.



UNIT 9 REFLECTION AND REFRACTION OF LIGHT

Activity 9.4: The bending of pencil

Fill three identical glasses with different amounts of water or fluid (oil etc.). Then put a pencil in each glass. Can you see part of the pencil that is in the water will appear bent?

It is because light travels more slowly in water than in air, and that causes the light to bend when it goes from water to air, or vice versa. And that makes the pencil look like it bends slightly where it enters the water.

9.8 SPHERICAL MIRRORS

Reflecting surfaces can also be curved, which means they form a section of a sphere. As Figure 7.15 (a) shows, a spherical mirror has the shape of a section sliced from the surface of a sphere. Spherical mirrors are of two types

- **Concave Mirrors** are the mirrors for which the inside surface of the spherical section is made reflecting.
- **Convex Mirrors** are the mirrors for which the outside surface of the spherical section is made reflecting.

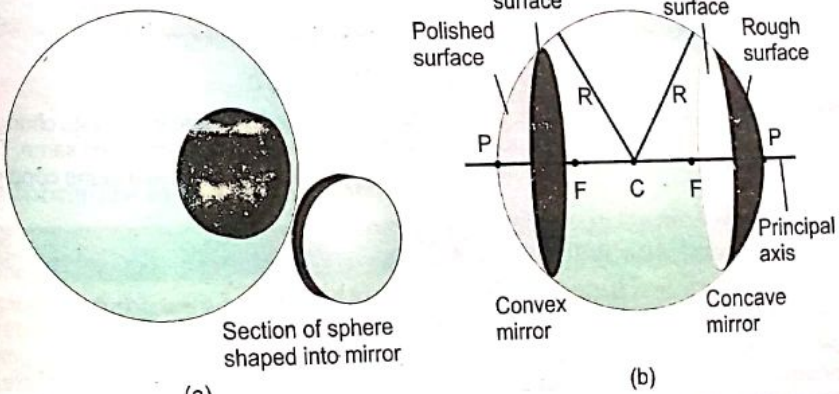


Figure 9.15 - Spherical mirrors

Center of curvature 'C' is the center of the sphere of which the mirror is formed.

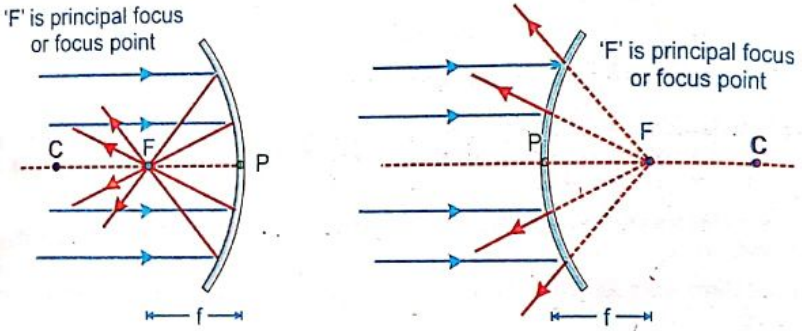
Radius of curvature R is the radius of sphere of which the mirror is a section.

Pole P is the midpoint of the spherical mirror formed.

Principal axis is a straight line drawn through the center of curvature and the pole.

FOCAL POINT "F" AND FOCAL LENGTH "f"

When a beam of light is directed toward either a convex or a concave mirror along its principal axis, after reflecting from the mirror, the rays converge or diverge as if they originated from a single point (in front or behind the mirror) called the focal point, F (or principal focus) as shown in figure 9.16. *Focal length of the spherical mirror is the distance from the pole of the mirror to the focus point of the object.*



(a) The concave mirror has the ability to converge the beam of light parallel to principal axis. Therefore it is also termed as converging mirror.

(b) The convex mirror has the ability to diverge the beam of light parallel to principal axis. Therefore it is also termed as diverging mirror.

Figure 9.16 focal point and focal length

When you move a plane mirror away from your face, the only image characteristic that changes is the distance of the image from the mirror. The other three characteristics remain the same. The images formed by curved mirrors are much more varied, particularly in the case of the concave mirror.

Activity 9.5 Shaving mirror

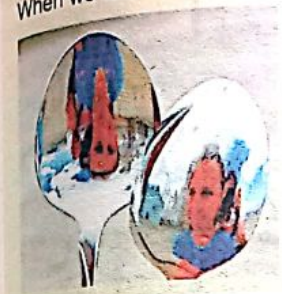
If you have a make-up or shaving mirror at home, hold it up to view your image in the mirror as you back away from it across the room. What do you observe?

Did you noticed that, as you first move away from the mirror, the image of your face is upright and gets larger, then it disappears. As you continue moving away, your image re-appears but it is now upside down. When you still continue to move away from the image gets smaller and smaller.

UNIT 9 REFLECTION AND REFRACTION OF LIGHT

STOP AND CHECK

When we look into the front side of a shiny spoon, we see an inverted image. When we look at the back side of the spoon, our image is upright. Why?



Actually we are alternately looking at concave and convex mirrors. Looking into the front of the spoon, we are outside the focal length of concave mirror and the image is inverted. Looking at the back of the spoon our image is upright as convex mirrors give upright images only. Get a spoon and check it out.

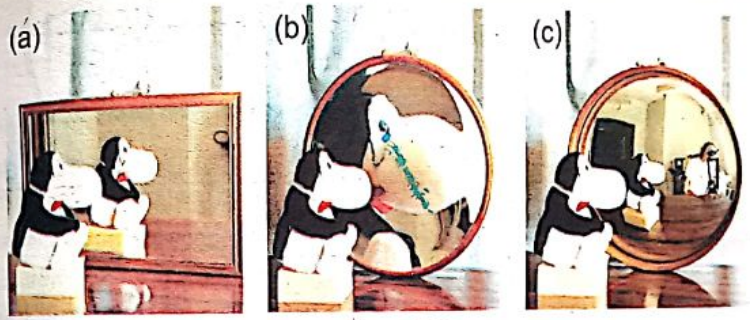


Figure 9.17
(a) Plane mirror image with no magnification.
(b) Enlarged image in a concave mirror.
(c) Reduced image in a convex mirror.

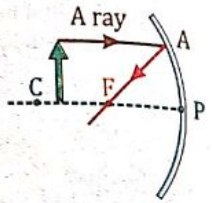
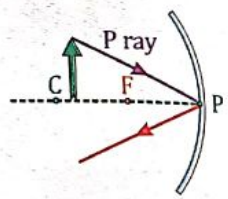
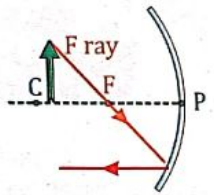
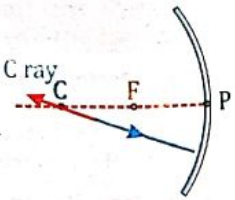
Image formation in concave mirror

How can a single mirror shape form so many different kinds of images? All possible classes of images that can be formed by concave mirrors depends up on the distance from the mirror.

The typical rays for concave mirrors are given in Table 9.2. Out of all these rays take any two rays, if the reflected rays are converging, we extend them until they cross. If the reflected rays are diverging, extend them back behind the mirror with dashed lines to meet each other. The point at which the rays meet is the position of the top of the image.

To locate the bottom of the image, we place the base of the object on the line principal axis. Since the line is perpendicular to the mirror, an incident ray would reflect directly backward. Thus, the base of the image will lie somewhere along this line.

TABLE 9.2 - RAY TRACING CONCAVE MIRRORS

Description	Comments	Illustration
Light ray # A Draw a ray from the top of the object to the mirror parallel to the principal axis. Draw the reflected ray through the focus point.	Since this incident ray is parallel to the principal axis, it will reflect through the focus point.	
Light ray # P Draw a ray from the top of the object to the pole P. Draw the reflected ray according to the law of reflection.	The ray incident on the pole 'P' of the mirror is reflected back making the same angle of reflection with principal axis as incidence ray makes according to the laws of reflection.	
Light ray # F Draw a ray from the top of the object through the focus point and on to the mirror. Draw the reflected ray parallel to the principal axis.	Any incident light ray passing through the focus point will reflect back parallel to the principal axis.	
Light ray # C Draw a ray from the top of the object through the center of curvature and on to the mirror. Draw the reflected ray antiparallel over it.	The ray of light passing through the center of curvature of concave mirror is reflected back along the same path.	

UNIT 9 REFLECTION AND REFRACTION OF LIGHT

The following results are obtained by changing the distance from the concave mirror.

A. OBJECT BEYOND THE CENTRE OF CURVATURE: When the object is beyond the centre of curvature the image formed is shown in figure 9.18, with the following characteristics

- **magnification:** the image is reduced (smaller in size than the object).
- **position:** the image is between center of curvature and focus point
- **attitude:** the image is inverted
- **type:** the image is real

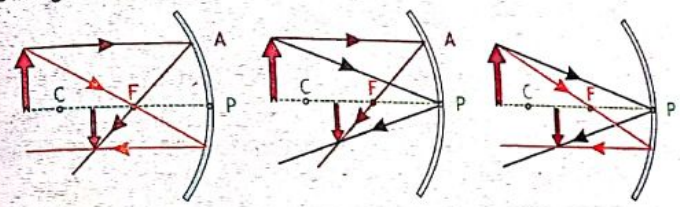


Figure 9.18 Three different kind of ray combinations for object beyond the centre of curvature

B. OBJECT AT THE CENTRE OF CURVATURE: When the object is at the centre of curvature the image formed is shown in figure 9.19, with the following characteristics

- **magnification:** the image is of the same size as the object
- **position:** the image is at the center of curvature
- **attitude:** the image is inverted
- **type:** the image is real

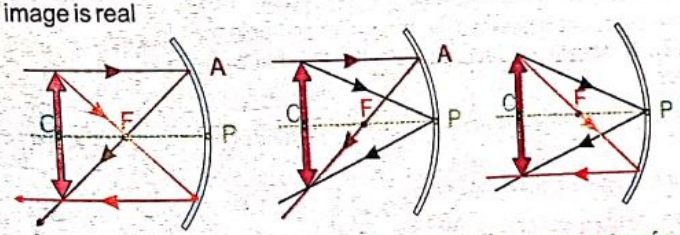


Figure 9.19 Three different kind of ray combinations for object at centre of curvature

Teaching Point: Three different combinations of rays are given only to realize students that they can take any two rays to form the image of the object.

C. OBJECT BETWEEN THE CENTRE OF CURVATURE AND THE FOCAL POINT: When the object is between the centre of curvature and focal point the image formed is shown in figure 9.20, with the following characteristics

- **magnification:** the image is enlarged (larger in size than the object).
- **position:** the image is beyond the center of curvature
- **attitude:** the image is inverted
- **type:** the image is real

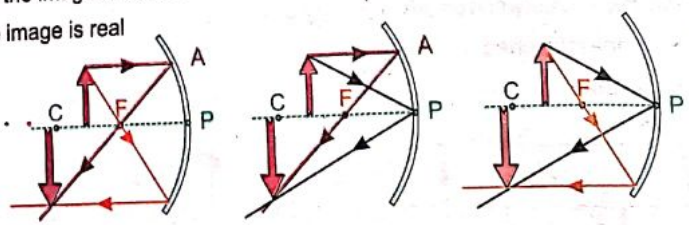


Figure 9.20 Three different kind of ray combinations for object between centre of curvature and focal point

D. OBJECT AT FOCAL POINT: When the object is at the focal point the image formed is shown in figure 9.21, the light rays are parallel and from same point on the object they neither converge nor diverge therefore no image is formed.

Alternatively we can say a highly enlarged image is formed which is real and inverted, at infinity.

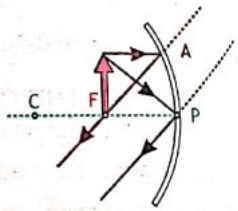


Figure 9.21 Object at focal point

OBJECT BETWEEN THE FOCAL POINT AND THE POLE: When the object is between the focal point and pole the image formed is shown in figure 9.22, with the following characteristics

- **magnification:** the image is enlarged (larger in size than object).
- **position:** the image is behind the mirror
- **attitude:** the image is upright
- **type:** the image is virtual

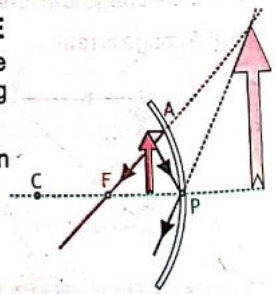


Figure 9.22 Object between focal point and pole

Activity 9.6 Car rearview mirror

Sit in the driver's seat of a car, look at an object in the back view mirror inside the car, and then look at the same object through the passenger-side outside mirror. What do you observe?

The passenger side mirror is actually convex mirror. The image in the passenger-side mirror is smaller than the one in the plane mirror inside the car.

Image Formation in Convex Mirror

The rays of light are also used to locate the image from convex mirrors. The directions for drawing ray diagrams for convex mirrors are given in Table 9.3.

Just as we did it for concave mirrors, take any two rays from table 9.3, however in this case the reflected rays will always be diverging, therefore, extend them back behind the mirror with dashed lines to meet each other. The point at which the rays meet is the position of the top of the image. Similarly obtain the bottom part of the image.

The image formation is drawn in the figure 9.23 with the following characteristics.

- **magnification:** the image is smaller in size as the object
- **position:** the image is between pole and focus point
- **attitude:** the image is upright
- **type:** the image is virtual

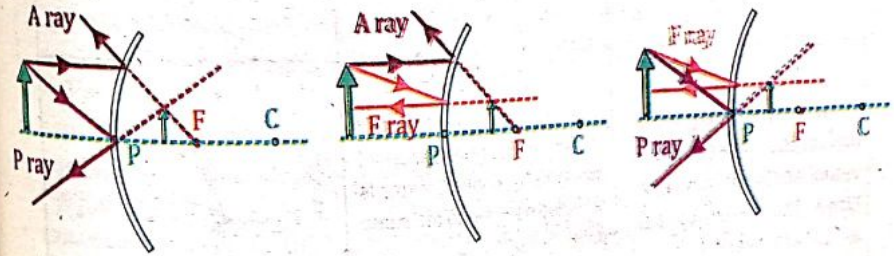
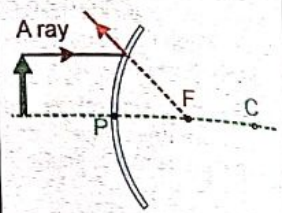
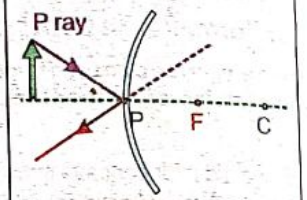
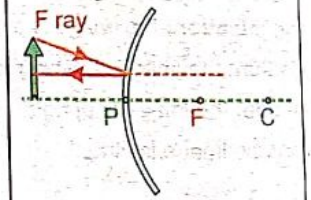
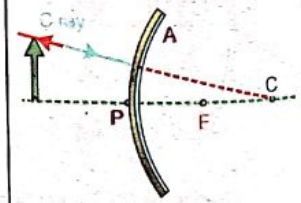


Figure 9.23 Three different kind of ray combinations for convex mirror

TABLE 9.3 RAY TRACING CONVEX MIRRORS

Description	Comments	Illustration
Light ray #A Draw a ray from the top of the object to the mirror parallel to the principal axis. Draw the reflected ray as though it were coming from the focus point.	Any incident ray that is parallel to the principal axis, will reflect along a line from the focus point, through the point where the parallel ray meets the mirror.	
Light ray # P Draw a ray from the top of the object to the pole P. Draw the reflected ray according to the laws of reflection.	The ray incident on the pole 'P' of the mirror is reflected back making the same angle of reflection with principal axis as incidence ray.	
Light ray # F Draw a ray from the top of the object towards the focal point behind the mirror. Stop the ray at the mirror. Draw the reflected ray parallel to the principal axis.	Any incident light ray directed towards the virtual focal point will reflect back parallel to the principal axis.	
Light ray # C Draw a ray from the top of the object towards the virtual center of curvature. Draw the reflected ray antiparallel over it.	The ray of light directed towards the virtual center of curvature of convex mirror is reflected back along the same path.	

UNIT 9 REFLECTION AND REFRACTION OF LIGHT

Convex mirrors are generally used when wide field of view is required, compared to a plane mirror.

Convex mirrors are installed in sharp turns in hilly areas to avoid vehicles from colliding as shown in figure 9.24. Convex mirrors are used because they give an upright image and provide a wider field of view. As they are curved outwards, this enable the drivers to navigate blind spots and look for approaching traffic through the mirror.

Figure 9.24 convex mirror installed at sharp turns on roads

Key Points

- When light interacts with matter it can be transmitted, absorbed and reflected.
- In one second light travels a distance of about 300,000 kilometres.
- Light travels in straight lines called rays.
- The two laws of reflection describe the behaviour of the incident and reflected rays. These are:
  - The incident ray, the reflected ray, and the normal to the surface all lie in the same plane.
  - The angle of reflection equals the angle of incidence.
  - An image which can be obtained on a screen is called a real image.
  - An image which cannot be obtained on a screen is called a virtual image.
- Light is a mixture of many colours and an object has a colour of light that it reflects.
- Refraction is the bending of light from its straight path as it passes from one medium into another.
- A spherical mirror is a section of a sphere of radius R.
- Concave Mirrors are the mirrors for which the inside surface of the spherical section is made reflecting.
- Convex Mirrors are the mirrors for which the outside surface of the spherical section is made reflecting.

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. A ray of light is incident towards a plane mirror at an angle of 30-degrees with the mirror surface. What will be the angle of reflection?
   a. 30° b. 60° c. 90° d. 45°
2. If the angle of incidence is 45°, then what will be the angle of reflection?
   a. 0° b. 45° c. 90° d. 180°
3. Which letter after reflection from a plane mirror will remain unchanged?
   a. K b. E c. M d. J
4. When light enters from air to water it
   a. continue its path as straight line. b. bends toward the normal.
   c. bends away from the normal. d. reflects totally.
5. The light passing from air to glass will cause the speed of light to
   a. remain the same. b. increase. c. decrease. d. reduce to zero.
6. For concave mirror real and inverted image of same size is formed when an object is
   a. beyond centre of curvature. b. at centre of curvature.
   c. between centre of curvature and focus point.
   d. at focus point.
7. For concave mirror, no image formed when an object is
   a. beyond centre of curvature. b. at centre of curvature.
   c. between centre of curvature and focus point. d. at focus point.
8. To get an enlarge and upright image, which mirror we should use
   a. convex mirror. b. concave mirror.
   c. plane mirror. d. rough mirror.
9. The Figure shows the plane mirror image of the clock the correct time is
   a. 2: 35 b. 3: 25 c. 8: 05 d. 9: 25

10. A dentist use a small dental mirror to help magnify teeth in your mouth. This mirror can be a
    a. convex mirror b. concave mirror
    c. plane mirror d. all of these

B. Short questions

1. How can we see ordinary, nonluminous objects?
2. Do you need a full-length mirror to see your hair and your feet at the same time? Does it depend on how far you stand from the mirror?
3. What is the minimum number of mirrors needed to see back of your head?
4. At which position does the image and object has same magnification?
5. Can a convex mirror produce a real image of an object?

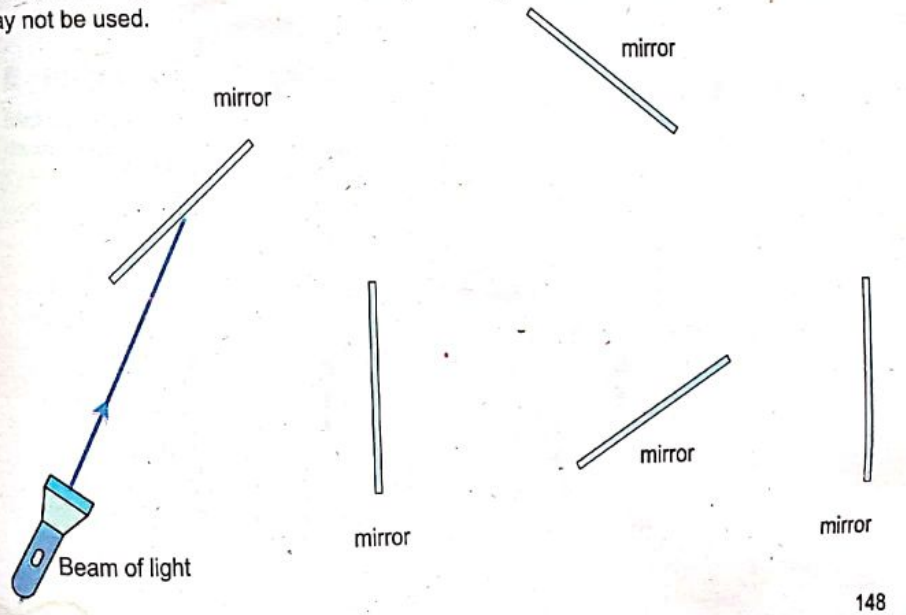
C. Long questions

1. State laws of reflection. Discuss how a plane mirror forms a virtual image.
2. What is white light? How is the colour of light related to reflection and absorption of light?
3. Explain the image formation by convex and concave mirrors.

D. Structured response questions

1. Series of plane mirrors and starting point for a light beam is shown in the figure. You are required to draw the path of light, showing (incident ray, reflected ray and normal) in each reflection.

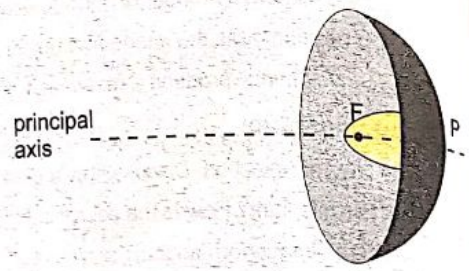
Note that the angle of incidence must be equal to angle of reflection and that all the mirrors may not be used.



2. Concave mirrors are widely used in headlights of automobiles and motor vehicles, torchlights, etc. as reflectors. The light source is placed at the focus of the mirror

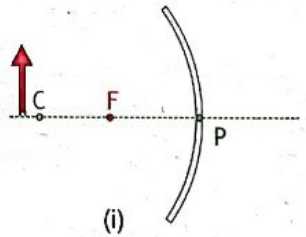
(a) Draw the ray diagram of this design?

(b) What is the advantage of placing bulb at the focus of concave mirror?

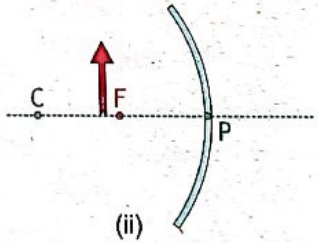


3. Concave mirrors with object position are shown in the figure given below. Draw the ray diagram for the image of the object and reply the following questions?

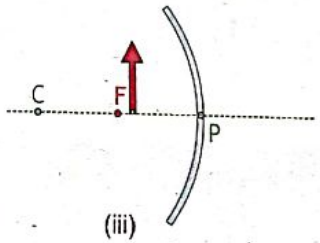
(a) Which diagrams shows highest and lowest image magnification? (b) In which diagram the image is upright and virtual?



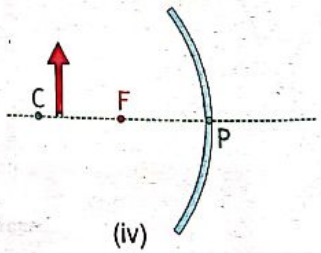
(i)



(ii)

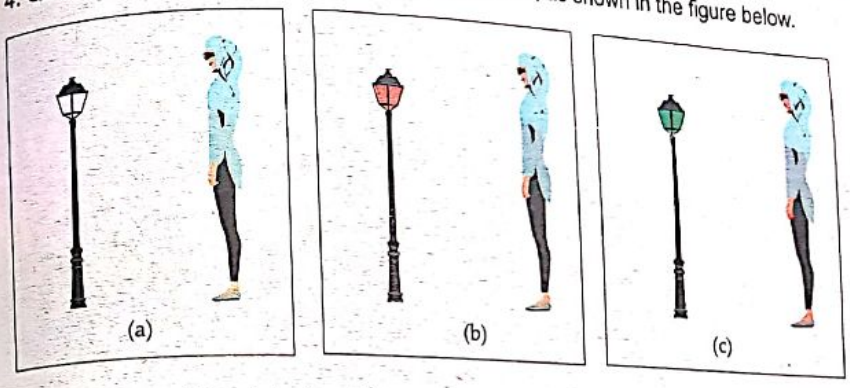


(iii)



(iv)

4. Qurat-ul-Ain is wearing glasses with red colour filter, as shown in the figure below.



(a) She uses red filter to look at the lamp that gives white light, but the lamp appear red. Explain how is this possible.

(b) Now she looks at red light lamp with red filter on her glasses. What colour will the lamp appear to her?

(c). What colour will a green light appear to her when she is wearing her red filter glasses. Why?

E. Project work

Make a poster showing difference between reflection and refraction of light with daily life examples.

UNIT 10

ELECTRICITY AND MAGNETISM

Learning outcomes:

At the end of this unit, students will be able to:

- Define resistance and its SI unit.
- Define voltage and current and state their SI units.
- Formulate that resistance is the ratio of voltage to current.
- Define electric power and state its unit.
- Recognize the electric power of various electrical appliances.
- Recognize the terms earth wire, fuse, circuit breaker.
- Analyze the danger of overloading and short circuit and identify the importance of earth wire, fuses and circuit breakers.
- List precautionary measures to ensure the safe use of electricity.
- Investigate the factors that affect the strength of an electromagnet.
- Describe the properties that are unique to electromagnets (i.e., the strength varies with current, number of coils, and type of metal in the core; the magnetic attraction can be turned on and off; and the poles can switch).
- Describe briefly the working principles of electromagnetic devices such as speaker, doorbell.

Why using washing machine we always have to connect it to electric power outlet? The washing machine works as long as electric energy is supplied to it. If there is interruption in supply of electric energy it will stop working. The same is true for all other electric appliances.

Electric power lights our homes, makes us connected through cell phones and help us to work with computers. Electric energy is used to run air conditioners. electric heaters, refrigerators, televisions and toasters. Lightning flashes in the sky because of electric energy.

Figure 10.1 Washing Machine

10.1 ELECTRIC CURRENT

Electric energy is the energy associated with electric charges. In most cases this electric energy is in the form of motion of charges (usually electrons).

'Time rate of flow of charge is called electric current'.

Electric current is represented by letter 'I'.

We can also explain electric current in such a way that it is a flow of charged particles, like electrons or ions. The number of these charged particles flowing past a region (in case of wire this is a cross sectional area) in certain unit time gives current. When the current is high, more charges pass through the point every second. In electric circuits the charges are electrons moving through a wire as shown in figure 10.2. When the current is high, more charges pass through the point every second.

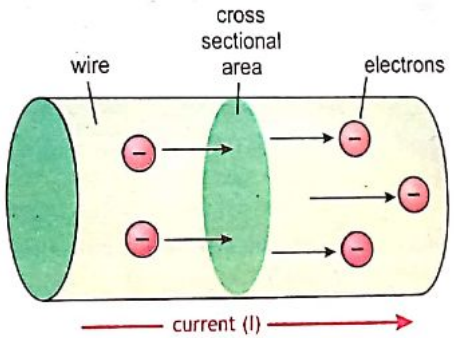


Figure 10.2 Electrons moving through a wire constitutes a current (I)

Current is any flow off charge however in most materials (like a metal wire), electrons are free to move, which produces the current. SI unit of charge is coulomb.

Unit of Current

The SI unit of current is the **ampere** and is represented by capital letter '**A**'. When one coulomb charge flows through any point in one second the current is one ampere.

$$1\ A = 1\ C/s.$$

The ampere is a large unit of current. In everyday situations we deal with small values of current. Small currents are measured in milliampere [mA] and microampere [μA].

10.2 VOLTAGE

When we are on a bike at the top of a hill, we can easily roll down to the bottom. Similarly the water tank of the house is constructed on the top of house, so that the water can flow easily anywhere in the house. In both these examples the difference in height (or gravitational potential energy) is important. This process can also occur in an electric circuit.

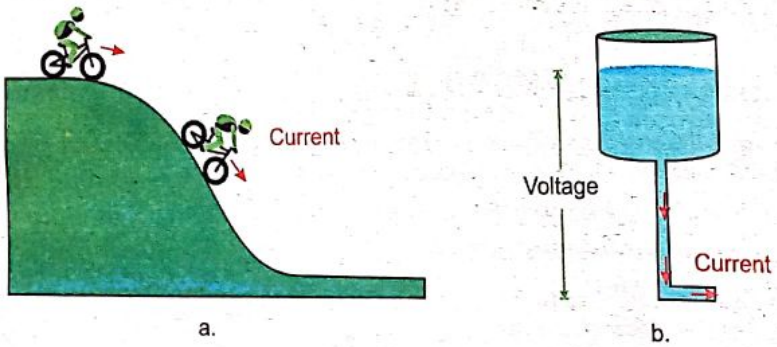


Figure 10.3 Gravitational potential energy and electric potential energy

In the figure 10.3 (a), the rolling of biker is equivalent to current and the height and steepness of curve represent the voltage. While in the figure 10.3 (b), the water flow is equivalent to current and the height of water increases pressure and is equivalent to the voltage.

'Voltage is the difference of electric potential between two points in a circuit'. Voltage is represented by letter 'V'.

The voltage between two points on a wire causes charges to flow through the wire. The size of the current depends on the voltage. If the voltage between two points on a wire is increased, more electric current will flow through the wire.

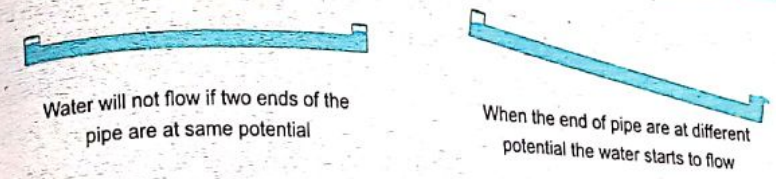


Figure 10.4 Just like a difference in potential causes water to flow, similarly the difference in electric potential (voltage) causes electron to flow (current).

UNIT OF VOLTAGE

The SI unit of voltage is **volt**, represented by capital letter 'V'. Voltage between two points will be one volt if one joule of energy is used to move one coulomb of charge from one point to another.

$$1\ V = 1\ J/C$$

INTERESTING FACTS

In a typical lightning flash the voltage is about 300 million volts and current is about 30,000 amperes. In comparison at home we use voltage of 230 volts and current of 20 amperes. In lightning air in the vicinity is heated to a temperature of 20,000 °C, about three times the temperature of the Sun's surface.

10.3 ELECTRIC RESISTANCE

Have you ever thrown a ball in clear water? The water makes it hard for the ball to move ahead in the liquid. That is a type of resistance.

Electric resistance is the opposition to the motion of charge through a material. Resistance lowers the flow of current. If the voltage does not change, as resistance increases, the current decreases.

If a material offers a small resistance, less voltage would be required to push current through the circuit. If a material offers more resistance, then more voltage will be required to push the same current through the circuit. The value of resistance R is therefore obtained by dividing the voltage V by the current I it carries

$$R = \frac{V}{I}$$

Every material offers some resistance to the flow of current through it. Different materials have different resistance, and therefore can be broadly divided into two categories conductors and insulators.

- an electric conductor (like gold, silver, copper and aluminum) has a low resistance
- an electric insulator (like plastic, glass, rubber and cloth) has a high resistance

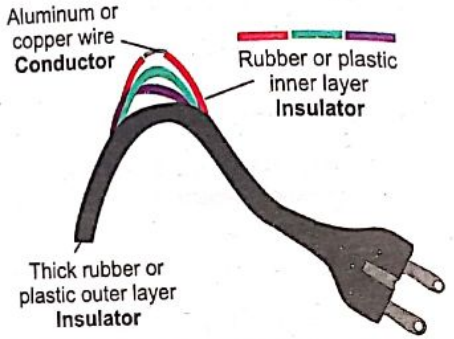


Figure 10.5 Electric conductors and insulators

In metallic conductors the charge is transported by free electrons. Resistance is due to collisions between these free electrons and fixed atoms inside the conductor.

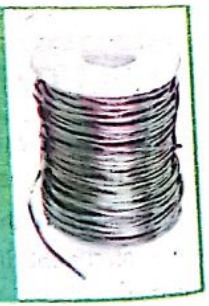
UNIT OF RESISTANCE

The **SI unit of resistance is ohm** and is represented by Greek letter (omega) Ω. **The resistance of wire is one ohm if potential difference of one volt is applied across its ends and causes a current of one ampere to flow through it.**

$$1\,\Omega = \frac{1\,V}{1\,A}$$

POINT TO PONDER

Wire Resistance: Although copper wire conducts electricity extremely well, it still has some resistance, as do all conductors. The resistance of a particular wire depends on all the three physical characteristics mentioned above such as (a) type of material, (b) length of wire, and (c) cross-sectional area. In addition, temperature can also affect the resistance.



UNIT 10 ELECTRICITY AND MAGNETISM

DO YOU KNOW?

What a resistor is?

Devices that are designed to have a specific value of resistance are called resistors and are made either from wires of special alloys or from carbon, a type of carbon resistor is shown in the figure. Those used in radio and television sets have values from a few ohms up to millions of ohms.

10.4 ELECTRICAL POWER

Many of the devices you use on a daily basis, such as the iron shown in Figure 10.6, require electrical energy to operate. The energy for these devices may come from a battery or from a power plant miles away.

Electric power is the rate at which electrical energy is used in a circuit.

When a charge moves in a circuit, it loses energy. This energy is transformed into useful work, such as the turning of a motor, and is lost as heat in a circuit. The rate at which electrical work is done is called electric power. Electric power (P) is the product of total current (I) in and voltage (V) across a circuit.

$$P = I \times V$$

Figure 10.6 Iron

Teaching Point: Give students different values of current and voltage and ask them to calculate the power. For example: A 9V battery is connected to an appliance in which current is 0.9 A. What is the current and power across the resistor? (Answer: 8.1 J/s or 8.1 W)

UNIT OF POWER

The SI unit for power is the watt (W). A watt is equivalent to 1 A × 1 V. Light bulbs are rated in terms of watts. For example, an electric LED bulb might be rated as 12 W. A typical hair dryer might be rated at 2000 W as shown in figure 10.7.

Figure 10.7 Electric appliances have different power rating

10.5 ELECTRIC SAFETY DEVICES

The devices and appliances that we operate in our home runs with high voltage, which is dangerous. For safe use of electricity fuses or circuit breakers are installed and earthing is made.

FUSES AND CIRCUIT BREAKERS

Fuse consists of a thin piece of metal wire, having low melting temperature as shown in Figure 10.8 (a). When excessive current flow through it, the wire piece inside it gets hot and melts. This disconnects the current flow through the wire, thus preventing any damage to the appliances they are connected.

UNIT 10 ELECTRICITY AND MAGNETISM

Nowadays circuit breakers as shown in Figure 10.8 (b) are used instead of fuses. Because they operate faster than fuses and can be reset by just pressing a button. In circuit breakers when the current exceeds, it separate a contact automatically and breaks the current path.

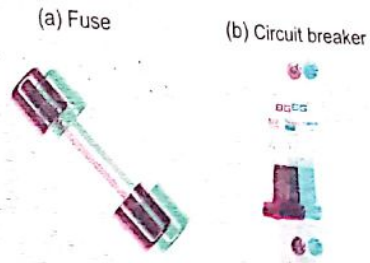


Figure 10.8 Fuse and Circuit breaker

POINT TO PONDER

To avoid the risk of electric shocks the metal body of an electric appliance is earthed / Grounded. Earthing means to connect meta case of an electric appliance (the neutral part of the supply system) to earth by means of earth wire as shown in figure. The current of the equipment passes to the Earth, which has zero potential, thus protecting the system and equipment from damage.

EARTH WIRE

If a current carrying wire inside a device connected to socket touches the body of a device, anyone handling it can receive a shock.

The earth pin on a three-pin plug (figure 10.9) is connected to the metal case of the appliance which is thus joined to earth by a path of almost zero resistance. If for example, an electric device breaks and touches the case, a large current flows to earth and 'blows' the fuse, thus preventing damage.

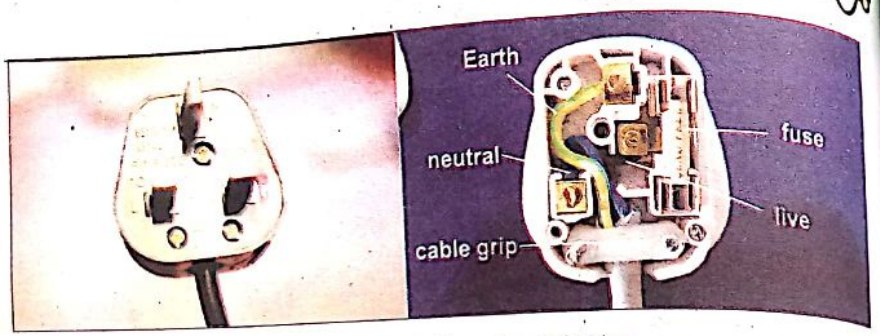


Figure 10.9 Earth pin on three pin plug

10.6 POTENTIAL HAZARDS IN USING ELECTRICITY

Electricity is beneficial but there are risks associated with it.

Electric shock

Electric shock occurs if current flows from an electric circuit through a person's body to earth. This can happen if there is damaged insulation or faulty wiring.

It is the size of the current (not the voltage) and the duration of time for which the current passes through the body which determine the strength of an electric shock. The effect of the shock depends on the path the current takes. Some body parts like heart and brain are more vulnerable than others.

Damp conditions increase the severity of an electric shock because water lowers the resistance of the body. Wearing rubber-soled shoes and gloves (figure 10.10) or standing on a dry insulating floor increases the resistance and will reduce the severity of an electric shock.

Figure 10.10 Electric safety gloves and shoes

To avoid the risk of getting an electric shock:

- Switch off the electric supply to an appliance before starting repairs.
- Use plugs that have an earth pin.
- Do not allow electric appliances or cables to come into contact with water. For example it is dangerous to hold a hair straightener with wet hands in a bathroom.
- Do not have long cables trailing across a room, because the insulation can become damaged.

FIRE RISKS

If the electric wiring in the walls of a house becomes overheated, a fire may start. Wires become hot when they carry excessive electric current.

Figure 10.11 Fire hazard of electricity

To reduce the risk of fire through overheated cables, the maximum current in a circuit should be limited by taking these precautions:

- Use plugs that have the correct fuse.
- Do not attach too many appliances to a single outlet (for example an extension box).
- Avoid using thin wires to operate appliances requiring large current.
- Damaged insulation or faulty wiring which leads to a large current flowing to earth through flammable
- material can also start a fire.

10.7 ELECTROMAGNETS

One of the most famous electric car company is Tesla. These electric cars require an electromagnet to run the engine.

In 1820, a Danish science teacher named Hans Christian Oersted first experimented with the effects of an electric current on the needle of a compass. He found that magnetism is produced by moving electric charges.

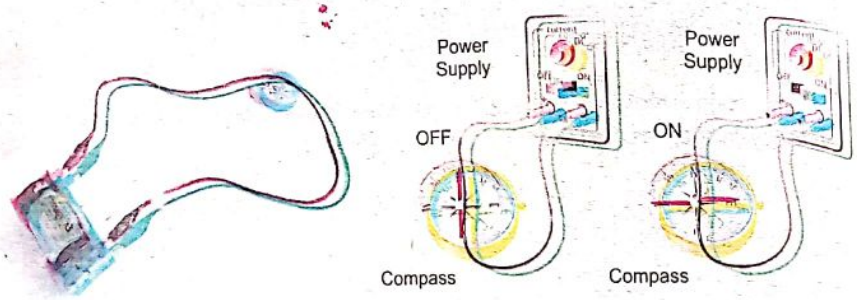


Figure 10.12 Using an apparatus similar to the one shown, We can demonstrate a connection between magnetism and electricity by applying current to the wire.

The magnetic field of wire created in the experiment is very weak. We can increase this magnetic field by increasing the current in the wire, but large current through wire will be heavily resisted and will heat it up and chances are that it catches fire.

A safer way to create a strong magnetic field that will provide a greater force is to wrap the wire into a coil, as shown in Figure 10.13. The magnetic field of each loop of wire adds to the strength of the magnetic field of the loop next to it. The result is a strong magnetic field similar to the magnetic field produced by a bar magnet. We can even have a north and south pole, just like a magnet.

The magnetic field produced with such an arrangement can be increased by inserting a rod made of iron (or some other potentially magnetic metal) called core through the center of the coils. The resulting device is called an **electromagnet** as shown in figure 10.13.

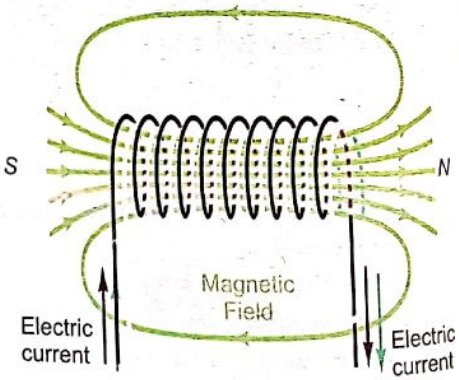


Figure 10.13 - Magnetic field of coil

UNIT 10 ELECTRICITY AND MAGNETISM

Electromagnet is a special magnet, because unlike permanent magnet, an **electromagnet**, can be turned ON / OFF by turning the current on or off. When the current flows through the coil, it is a powerful magnet. When the current is turned off, the magnetic field disappears.

When the current source or cell is reversed the direction of magnetic poles is also reversed, north becomes south and south turns north.

The strength of the magnetic field of a coil depends on the number of loops of wire and the amount of current in the wire. In particular, more loops or more current can create a stronger magnetic field.

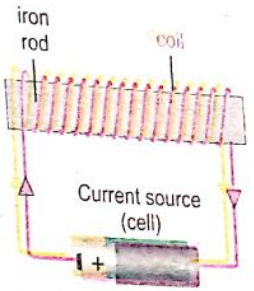


Figure 10.14 Electromagnet

Figure 10.15 Electromagnets are used in many practical applications. They can lift large masses of magnetic materials such as scrap iron rolls of steel and auto parts.

Teaching point: Compare the electromagnets with permanent magnets, in this topic to show students how effective are electromagnets. The permanent magnet cannot be turned on and off, its poles cannot be reversed, and its strength cannot be increased or decreased.

Activity 10.1 Making an electromagnet

Making an electromagnet

Wind the wire around the nail, as shown at right. Remove the insulation from the ends. Hold the insulated wire with the ends against the terminals. This system will form an electromagnet and will be able to attract objects (paper pins) just like magnet.

NOTE: The electromagnet that you'll construct in this experiment will become hot during use. Be prepared to drop the electromagnet if it becomes uncomfortably hot.

Move the compass toward the nail to determine whether the nail is magnetized. If it is magnetized, the compass needle will spin to align with the nail's magnetic field. Switch connections to the cell so the current is reversed. Again bring the compass toward the same part of the nail. What happens to the direction of the compass needle after you reverse the direction of the current? Why does this happen?

Try using a larger more powerful cell, did it make your electromagnet stronger? Can you lift more paper clips and even some more heavier objects?

Take some more wire and wound the nail more tightly. Can you lift more paper clips and even some more heavier objects?

Change the core of electromagnet from nail to some non magnetic material like twigs. Does the twig has made the electromagnet stronger compared to nail?

UNIT 10 ELECTRICITY AND MAGNETISM

CAN YOU TELL?

After detaching the core from the electromagnet it is magnetized and behave just like a permanent magnet. Try bringing the core (nail) close to the paper pins it will attract them. Is the nail a magnet? How it can be non magnetic?

10.8 APPLICATIONS OF ELECTROMAGNETS

Stereo Speakers

Electromagnets can even be used to produce sound waves. This is how most stereo speakers work. The speaker shown in Figure 10.16 consists of a round permanent magnet and an electromagnet attached to a paper cone. When a current passes through the coil, electromagnet is activated which interacts with the permanent magnet, causing the cone to move in one direction. When the current reverses direction, the magnetic force on the electromagnet also reverses direction. As a result, the cone accelerates in the opposite direction, making the speaker cone vibrate.

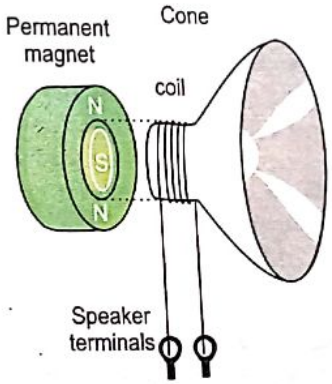


Figure 10.16 Stereo speakers

The cone vibrates with varying the magnitude of the current. These vibrations produce sound waves. In this way, an electric signal is converted to a sound wave.

Electric Bell

An electric bell also makes use of an electromagnet in it. Let us see how it works. Fig. 10.17 shows the circuit of an electric bell. It consists of a coil of wire wound on an iron piece. The coil acts as an electromagnet. An iron strip with a hammer at one end is kept close to the electromagnet. There is a contact screw near the iron strip. When the iron strip is in contact with the screw, the current flows through the coil which becomes an electromagnet. It, then, pulls the iron strip. In the process, the hammer at the end of the strip strikes the gong of the bell to produce a sound.

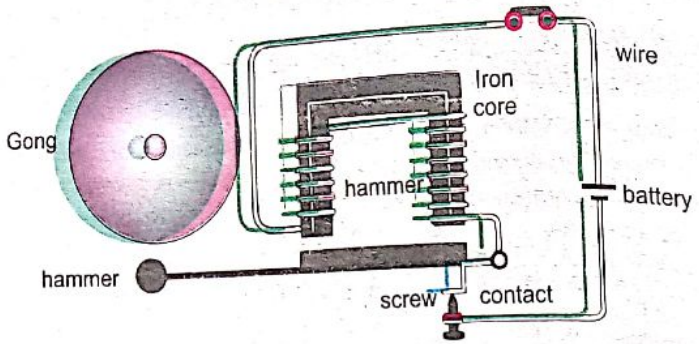


Figure 10.17 Electric Bell

However, when the electromagnet pulls the iron strip, it also breaks the circuit. The current through the coil stops flowing. The coil no longer remain an electromagnet, and thus after hitting the gong, the iron strip comes back to its original position and touches the contact screw. But again the circuit is completed and the current flows in the coil and the hammer strikes the gong again. This process is repeated in quick succession. The hammer strike the gong repeatedly and the bell rings.

Key Points

- Rate of flow of charge is called current.
- The difference of electric potential between two points is termed as voltage.
- The measure of opposition to the flow of current is called resistance.
- Device intended to offer resistance is called resistor.
- A fuse/circuit breaker is an electrical safety device used to prevent overloading in high current drainage.
- To avoid risks of electrical shock, the metal body of electrical appliance is earthed.
- Electromagnet is a coil that has a soft iron core and that acts as a magnet when an electric current is in the coil.
- The strength of electromagnet increases with increasing the current, increasing the number of turns in coil.

UNIT 10 ELECTRICITY AND MAGNETISM

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. Which of the following energy conversions takes place in a battery-operated flashlight?
   a. Electrical → mechanical → light b. Chemical → mechanical → light
   c. Chemical → electrical → light d. Nuclear → electrical → light
2. The unit of current is
   a. coulomb. b. volt. c. ohm. d. ampere.
3. Bulb is connected to voltage source, by increasing the voltage the brightness of the bulb will
   a. increase. b. decrease. c. reduce to zero. d. stay the same.
4. The primary purpose of a resistor is to
   a. increase current. b. limit current.
   c. produce heat. d. resist current change.
5. The wire made from which of the following material is a conductor
   a. glass. b. rubber. c. gold. d. silica.
6. The electric device which melts, if current exceeds a certain fixed value, are
   a. circuit breakers. b. fuses.
   c. earth wires. d. copper wires.
7. The device that is used to protect a circuit against overload is
   a. heater. b. fuse. c. lamp. d. switch.
8. To prevent risk of electric shock the earth pin on a three-pin plug is connected to the part of device
   a. plastic part of device. b. neutral wire. c. cable grip. d. metal case.
9. To increase the strength of the electromagnet the best core material should be
   a. plastic. b. rubber. c. aluminum. d. iron.
10. Electromagnetic device which make of electromagnet is
   a. resistor. b. bulb. c. door bell. d. three plug pin.

B. Short questions

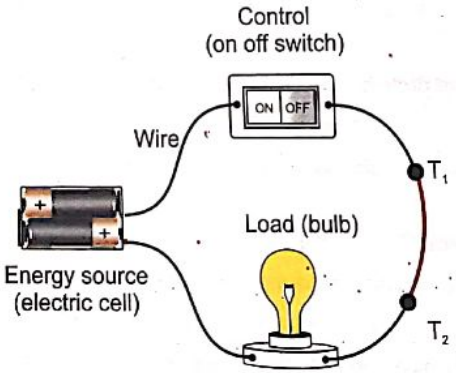
1. Why an electrical device need two conducting paths from a voltage source to operate?
2. Why do wires usually warm up when an electric current passes through them?
3. During a floor grinding and polishing repairs in your house, the fuse blows when the operator start his heavy machine. He wants to replace a fuse by a piece of wire. Would you agree? Give reasons for your response.
4. Explain why is it dangerous if we use hair dryer in a bath tub?
5. What advantage will a crane have with electromagnet over other cranes? Can it use a permanent magnet?

C. Long questions

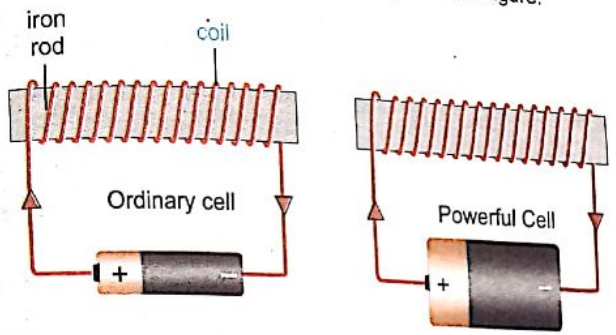
1. What is resistance and in what units we measure resistance?
2. State and explain electric power by giving its mathematical description.
3. What are electromagnets? Explain their uses in daily life.

D. Structured response questions

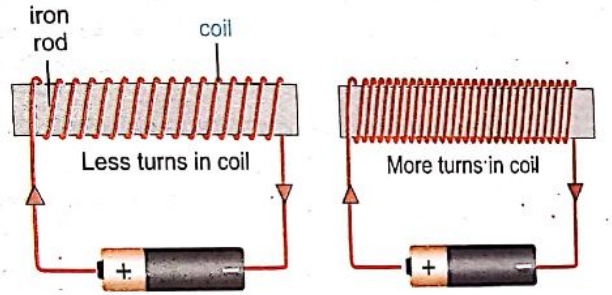
Q1. There is different resistance to flow of current by different materials. Consider the circuit shown in figure having two terminals T_1 and T_2.TWhen copper wire is connected between the terminals and switch is on the bulb glows. When Nichrome wire and plastic string having same thickness as copper wire replaces it, How would the glow change in each case?



Q2. Electromagnets with different arrangements are shown in the figure.



a. Why the powerful cell increases the strength of electromagnet?

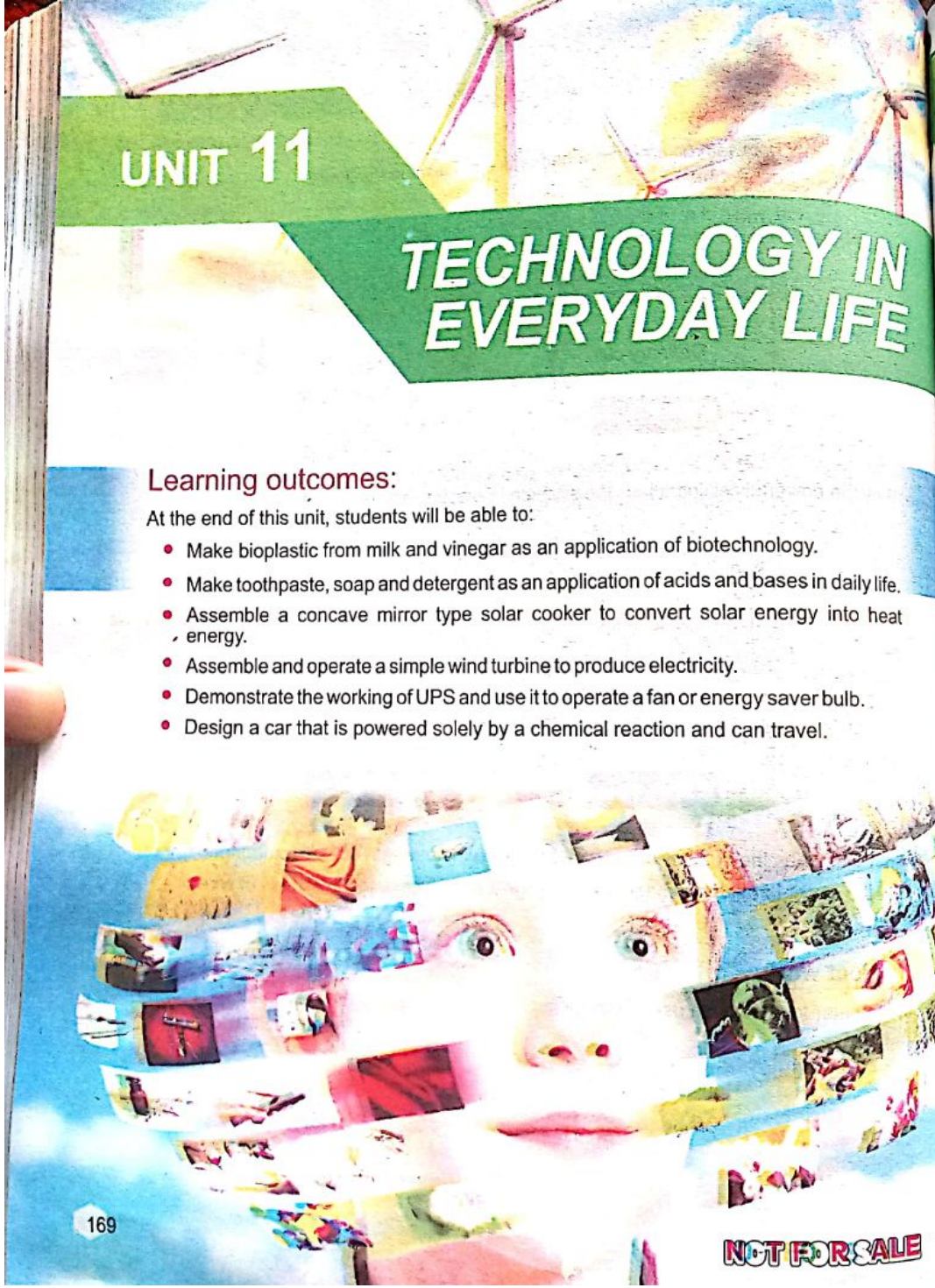


b. What effect has the number of turns in the coil on the strength of electromagnet?

c. How the strength of electromagnet will change if we increase the thickness of wire or size core?

E. Project work

Make a poster to show safe use of electricity.



UNIT 11

TECHNOLOGY IN EVERYDAY LIFE

Learning outcomes:

At the end of this unit, students will be able to:

- Make bioplastic from milk and vinegar as an application of biotechnology.
- Make toothpaste, soap and detergent as an application of acids and bases in daily life.
- Assemble a concave mirror type solar cooker to convert solar energy into heat energy.
- Assemble and operate a simple wind turbine to produce electricity.
- Demonstrate the working of UPS and use it to operate a fan or energy saver bulb.
- Design a car that is powered solely by a chemical reaction and can travel.

Things created by humans that has made life easier or comfortable is called technology. For instance, toothpaste, soap, detergent that we use for our personal hygiene, solar cooker to convert solar energy into heat, solar cells and wind turbines to produce electricity, UPS to operate fans and energy saver bulbs during electricity load shedding etc. Technology has brought so many changes in our lives, food and health. Now-a-days we have easy access to information through cellphones and laptops.

11.1 APPLICATIONS OF ACIDS AND BASES IN TECHNOLOGY

Toothpaste

Toothpaste helps to remove food debris and plague from your teeth and gums. Recall, bacteria decay food particles in your teeth and produce an acid. This acid causes tooth decay. Toothpaste contain an alkali, so brushing toothpaste neutralises acid and prevents tooth decay.

Activity 11.1 Make your own toothpaste

Materials Required:

- Glycerin 2 teaspoon
- Baking soda 3 teaspoon
- Peppermint oil 5 drops (optional)
- A pinch of salt

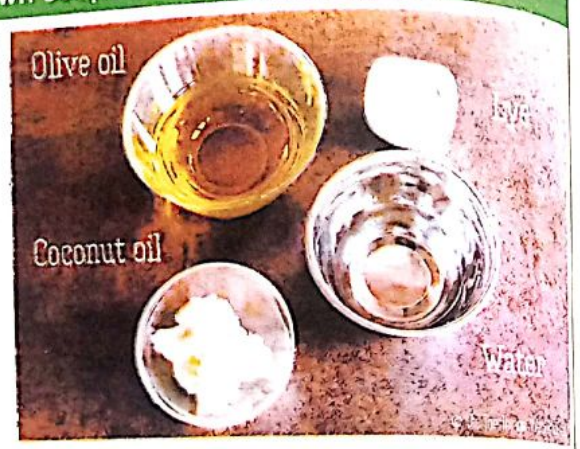
Procedure:

- Mix baking soda and salt in a mortar or any ceramic container.
- Add glycerin in it.
- Blend with pestle or spoon until you get a paste.
- Add few drops of peppermint oil or any other flavouring.
- Your toothpaste is ready.

Soap

Soaps are materials, when dissolved in water produce lather that can remove dirt from human skin, cloths and other solids. When oil or fats are heated with an alkali NaOH, sodium salts of fatty acids (organic acids) are formed. This reaction is known as saponification reaction. These salts are called soaps.

Activity 11.2 Make your own soap



Soap by definition is fat and oil mixed with alkali. It removes dirt from your skin and cloths.

Materials Required:

- Coconut oil 56g
- Olive oil 28g
- Pure sodium hydroxide also called lye 15g
- Distilled water 30g
- Essential oil any (optional)

Procedure:

- Wear disposable gloves and safety goggles.
- Pour water in a container and add lye in it and stir gently with a glass rod or wooden spoon. Don't add water into lye, this is unsafe. Reaction is highly exothermic and may produce fumes.
- When lye is completely dissolved, leave solution to cool to 100°C.
- Place coconut oil and olive oil in a pan and heat up to 50°C.
- Pour lye solution into mixture of oil and mix well (or blend well) until a thick paste is obtained.
- Pour the paste into molds.
- Cover mould first with cardboard and then with towel.
- Leave it for two days.
- Your soap is ready.

Milk Plastic

Milk is an important nutrient-rich liquid. It contains protein, fats, carbohydrates, calcium and vitamin D. What is your favorite food? Yogurt, cheese, cream or butter. These products are made from milk and are called dairy products. Milk contains a protein called casein. When milk is mixed with an acid, casein molecules combine to form long chain product called casein plastic or milk plastic. This plastic can be scooped up and molded.

Activity 11.3 Plastic from milk

You can make plastic from milk. Biotechnology can help you in making this plastic. Milk plastic is used for making buttons, decorative buckles, beads, combs, brushes etc.

Materials Required:

- 1 cup of milk
- 4 cups of vinegar
- A small pan, spoon, strainer and paper towel.

Procedure:

- Put one cup of milk in a pan and heat it until it is just warm.
- Put 4 cups of vinegar in it you will notice that milk starts separating into curds and whey.
- Stir it gently.
- Pour content of the pan into a strainer to remove whey. Milk plastic is left behind.
- Now press plastic with a spoon to remove left over whey.
- Now knead plastic with your hands.
- Use paper towel to remove any leftover moisture in it.
- Leave it to dry.
- You can make coloured milk plastic. For this add food colours to the milk before warming it.
- You can create your own toys, beads etc. from milk plastic.

Detergent

Detergent is a substance or mixture of substances used for washing and cleaning but they are not soaps. Their action is like soaps.

Activity 11.4 Make your own detergent

Materials Required

- Washing soda 2 cups
- Baking soda 2 cups
- Borax 2 cups
- Essential oil 2-3 drops (optional)

Procedure:

- Add ingredients in a container
- Place the lid on the container
- Shake ingredients to mix them thoroughly.
- Your detergent is ready

11.2 DESIGNING A CONCAVE MIRROR TYPE SOLAR COOKER

When objects are placed in direct sunlight they get warm. Steel and metals are sometime uncomfortably hot to hold. For example When we get into a car that has been parked in the sun on a hot day. We notice that the metal part of the seat belt buckle feels very hot.

The same principle can be employed to cook food.

Concave Mirrors are the mirrors for which the inside surface of the spherical section is made reflecting. When a beam of light is directed toward a concave mirror along its principal axis. After reflecting from the mirror, the rays converge to single point in front of the mirror called the focus point, F.

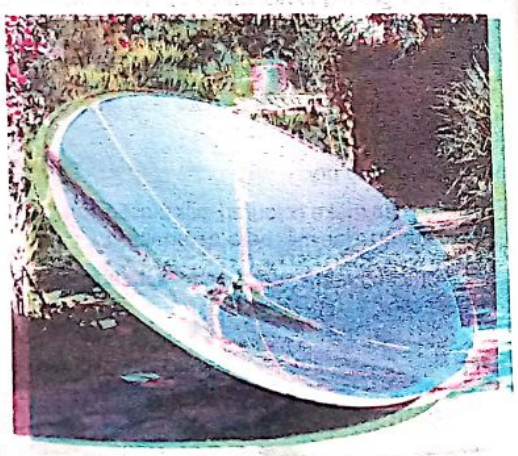


Figure 11.1 Concave mirror type solar cooker

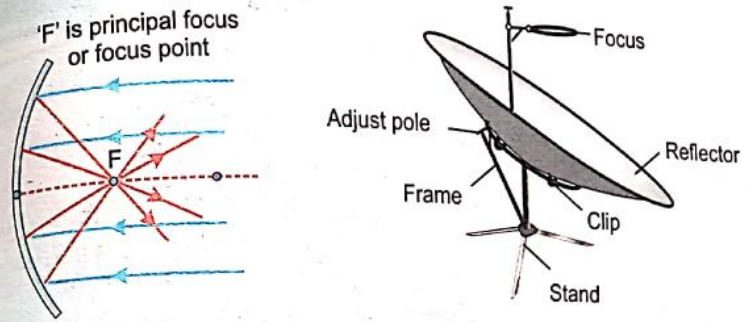


Figure 11.2 Concave mirror and solar cooker construction

This means that by using concave mirrors we can direct the energy in sunlight to a single point. This reflected light is very powerful because it carries a lot of thermal energy. Solar cookers are one of the simplest utensils used to cook food, it directs the sun light to cooking spot at the focal length of concave mirror. Since it does not use fire and is environment-friendly as it does not consume any fuel. It harnesses the power of the sun to cook food.

POINT TO PONDER

Solar parabolic cookers heat up fast and get very hot, thus they are ideally suited for grilling, boiling, steaming, frying etc. Because of the high heat, the rapid cooking, and the movement of the sun across the sky, it is not recommended to leave the cooking meal unattended.

Solar parabolic cooker construction

A parabolic solar cooker can be made from thin plywood sheets, as seen in figure 11.8.

Materials required:

- Thin plywood sheets, around 5mm in thickness
- Plastic or metal to stiffen parabola
- Rope or plastic cable
- Bolts, washers, nuts
- Aluminium foil

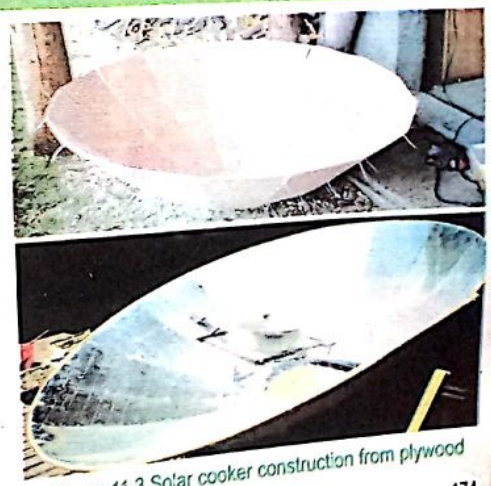


Figure 11.3 Solar cooker construction from plywood

The plywood can be cut in shape of petals. After the petals are cut, also cut two round sheets of plywood which will be used to connect the narrow ends of the petals (Figure 11.4). Use bolts, washers and nuts for the connection and sandwich the petals between these two round sheets of plywood.

Figure 11.4 The narrow ends of the petals connected by round sheets

Plastic ties (known as cable ties) can be used to keep the plywood petals together (Figure 11.5). It can be easier to fix the petals gradually from the centre to the edges of the parabola

Figure 11.5 Petals fixed with cable ties

Rope can be used in the end to give the petals a final shape

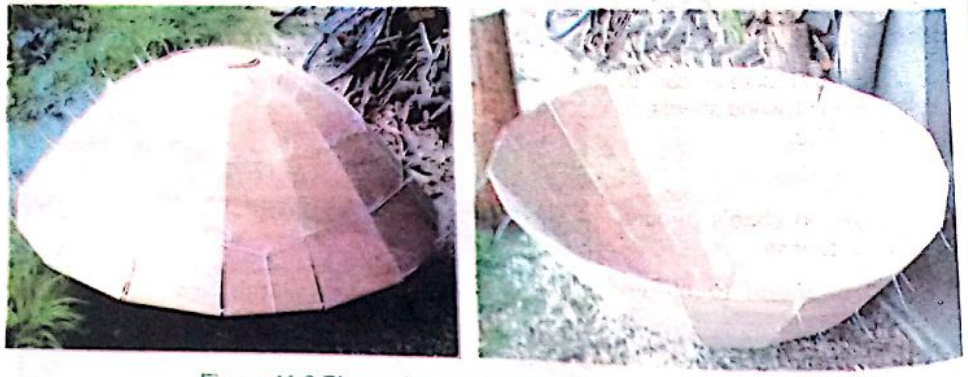


Figure 11.6 Plywood petals fixed to resemble a parabola

Adhesive aluminium tape can be put to the ready bent plywood petals.

Figure 11.7 Aluminium tape added to petals

Now the parabola needs a frame to complete the parabolic solar cooker construction. The frame should allow it to stay stable while in use. Keep in mind that the parabolic solar cooker can accumulate wind pressure due to its shape. The frame should be stiff enough and fixed to the ground, in such cases. A simple example of a frame is shown in figure below.
The frame should also support the cooking pot.

Figure 11.8 Frame to support the parabolic solar cooker

Activity 11.5: Cooking with solar cooker

Precautions:

Cooking with solar cookers require some safety instructions to be followed:

- The reflected light from cooker is dangerous for eyes. Avoid looking directly at it, or wear protection glasses
- Keep little children away from it as its metal parts get hot very quickly.
- Lets boil water in cooker, to kill parasites and other microbes
- Put a dark pot on the pot holder.
- Take solar cooker out in the sun and adjust its position.
- Measure the time it takes to boil water.
- Carefully remove the pot from the solar cooker.

Activity 11.6 Designing solar cooker

A parabolic solar cooker can be made using fiberglass. What are other ways you can use to create concave mirror type solar cooker? Try creating one and share your project with class.

11.3 DESIGNING A WIND TURBINE

Have you ever felt blown around by the wind? Wind can move things around and carries energy. Can we covert this energy into electric energy to make it more useful.

To change the wind energy to electricity, wind should turn the rotor blades which need to spin the turbine. Inside the turbine is an electric generator, which is a rotating machine that supplies an electrical output with voltage and current.

A wind turbine is connected to the motor, and its movement generates electricity. You can measure how much electricity (voltage) is produced with a voltmeter. So, when does a wind turbine work best? The power produced by a wind turbine depends on elevation, wind speed and air temperature.

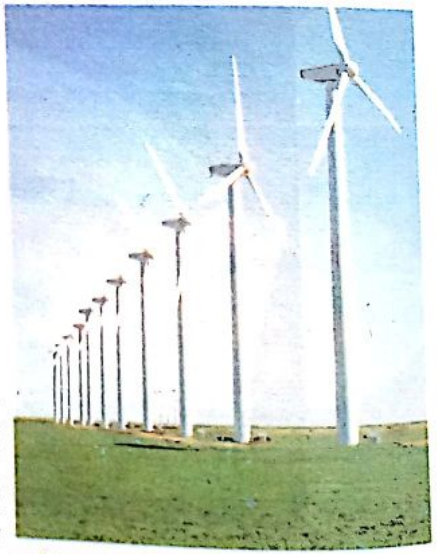


Figure 11.9 Modern wind turbines

UNIT 11 TECHNOLOGY IN EVERYDAY LIFE

Wind power is undergoing the fastest rate of growth of any form of electricity generation in the world. Wind power is emissions-free and wind is renewable and cost-free; however, the amount of electricity generated and obtained by wind energy conversion systems is still unsteady, relatively expensive and difficult to integrate into traditional electricity systems because of the variation in wind source and unresolved energy storage issue.

MAKING A WIND TURBINE

Materials required

- small DC toy motor
- 2 pieces of thin electrical wire with alligator clips, each about a meter long
- two light weight wooden sticks
- 4 pieces of cardboard,
- cylindrical-shaped cork, at least 2 cm or ¾ inch in diameter; alternative to cork: Styrofoam ball
- common pin
- empty plastic bottle 1.5 liter
- long nail or metal rod
- voltmeter and/or bulb
- scotch tape and scissors (if required).

Making blades for wind turbine

- Take two small light weight wooden sticks and attach cardboard with help glue gun to make blades of turbine as shown in Figure 11.10 (a).
- Stick the pieces together by passing a common pin through their centers to stick blades of turbine with each other as shown in Figure 11.10 (b).
- Pass the common pin inside the cork as shown in Figure 11.10 (c).

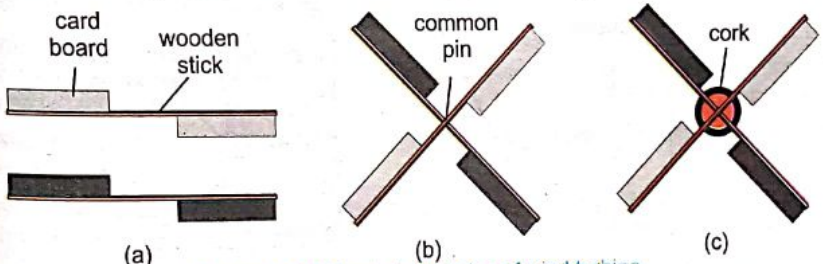


Figure 11.10 Designing blades of wind turbine

MAKING MOTOR CONNECTIONS AND SUPPORT

- Attach wires with DC motor and mount it on long nail or some other support material as shown in Figure 11.11 (a).
- Get an empty plastic soda bottle and fill it with sand to make support for the DC motor as shown in Figure 11.11 (b).

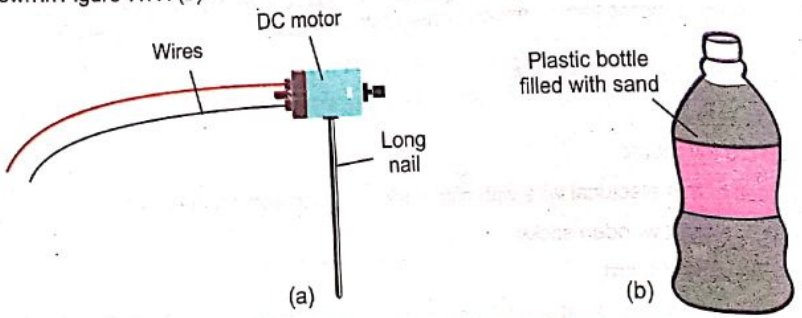


Figure 11.11 Making DC motor connections and support

- Connect blades of turbine with DC motor and support as shown in the Figure 11.12.
- Attach the wires from DC motor with voltmeter (a voltage measuring device).

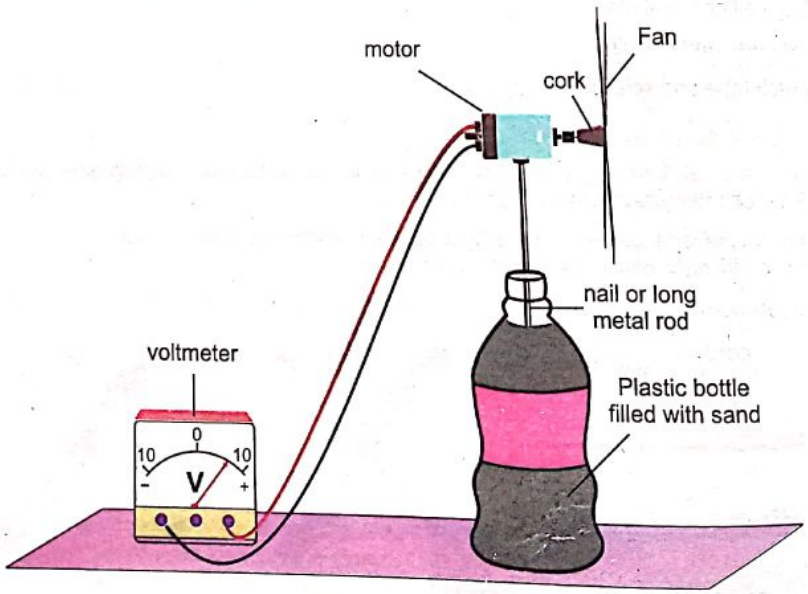


Figure 11.12 Wind turbine experimental setup

UNIT 11 TECHNOLOGY IN EVERYDAY LIFE

- At measured distance from wind source (Pedestal fans or 'Stand Fans'), measure the voltage produced.
- Repeat with the wind turbine at different distances from the wind source and record the voltage readings.
- Try to lit the small bulb with the wind turbine.

Sr No	Distance from fan	Voltage measured
1		
2		
3		
4		

FINDINGS

- What was the maximum voltage produced?
- What happened as you moved your wind turbine closer or farther away from the wind source?
- What factors might engineers consider when deciding where to put a wind turbine generator or a wind farm?

DO YOU KNOW?

- **Wind power is not new**. Human civilizations have harnessed wind power for thousands of years. Early forms of windmills used wind to crush grain or pump water. Now, modern wind turbines use the wind to create electricity.
- **Wind turbines look simple but they are actually very complex.** Modern wind turbine has around 8,000 different parts.
- **Wind energy in Pakistan** makes up more than 6% of the total electricity production in the country.

Activity 11.7 Designing wind turbine

Make a wind turbine with changing shape of the blades of wind turbine (Concave shape, use Styrofoam cups). What are the changes in the voltage produced?

11.4 WORKING OF UPS

UPS stands for **U**ninterruptible **P**ower **S**upply, it is also known as a battery backup, provides backup power when your regular power source fails or voltage drops to an unacceptable level. A UPS allows for the safe, orderly shutdown of a computer and other equipment connected. The size and design of a UPS determine how long it will supply power.

UPS uses battery to control interruption in power supply. It detects loss or reduction in primary power source, the control is transferred to the batteries and DC voltage in batteries is converted to AC using an inverter for the devices that run using AC.

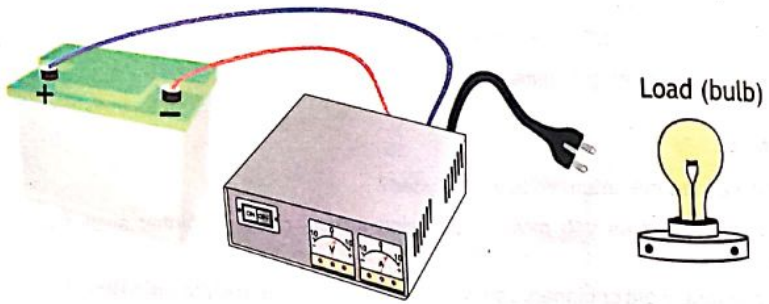


Figure 11.13 UPS

Plug the charger into the wall and power it ON. Make sure it begins a proper charge cycle, and make sure the inverter is powered OFF.

Attach and test the inverter if it is separate from the charger. Hook up the cables to the batteries, noting polarity. Turn the inverter on and test it with some suitable AC load.

Take a UPS system and connect it with a bulb as load. After charging for some time turn OFF the power to the UPS, the light will continue glowing.

Teaching Point: Teacher will practically explain input and output of UPS

Activity 11.8 Chemical reaction and engineering in action

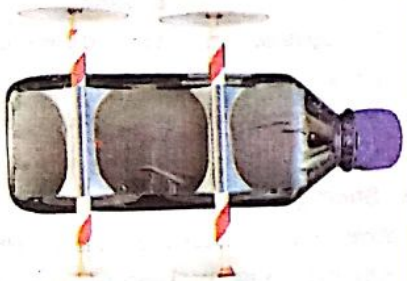
You will need:

- Square shaped plastic water bottle
- One straw
- One bamboo skewer
- Four plastic caps
- Four pony beads
- Scissor
- Glue
- A nail
- Duct tape
- Tissue paper
- Baking soda
- Vinegar
- Tong

Steps:

1. Heat the tip of nail on the spirit lamp or burner. Caution! Adult supervision is required.
2. Gently insert the hot tip of nail into the centre of the water bottle lid, to make a fine hole in it.
3. Cut the paper straw into two half.
4. Cut the bamboo skewer into two pieces, each piece should be 2.5cm longer than the straw pieces.
5. Fix a pony bead with glue into the centre of plastic caps to make four wheels.
6. Put some glue into the centre of the pony bead and insert one end of the bamboo skewer. Let it dry.
7. Now insert this bamboo skewer into the straw.
8. Fix the other end of bamboo skewer into another wheel with glue. Let it dry. Here you will get one axle.
9. Repeat steps 6, 7 and 8 to make another axle.
10. Fix these two paper straw on the bottle with duct tape. Now car is ready.
11. Cut a 12cm x 8cm rectangle tissue paper. Pour one teaspoon of baking soda on it. Roll up and fold the end to prevent baking soda falling out.
12. Open the water bottle and pour one cup of vinegar into the bottle, and keep it upright.
13. Insert baking soda tissue roll into the bottle and close its mouth with the cap.
14. Shake bottle and place car wheels on smooth surface.

Observe what happens?



Activity 11.8 Cont....

What makes the car go?

When baking soda and vinegar are mixed together, a chemical reaction occurs and carbon dioxide is produced. This carbon dioxide builds pressure inside the bottle and escape through the hole in the cap. The force of escaping carbon dioxide causes an equal and opposite force in the other direction. This opposite force makes the car move.

Key Points

- Concave mirror type solar cooker or parabolic solar cooker are usually made from curved reflective sheets or small mirrors (metal, plastic or plywood covered with reflective foil). It focus solar radiation on a small area, where the cooking pot is placed.
- A wind turbine is a device that converts the wind's kinetic energy into electrical energy.
- An uninterruptible power supply (UPS) is an electrical device that gives emergency power to a load when the main power source fails.

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. Which of the following is **NOT** a component of toothpaste?
   a. Glycerine b. Baking soda c. Lye d. Salt
2. Which substance is used to make milk plastic?
   a. Baking soda b. Glycerine c. Vinegar d. Borax
3. What type of mirror is used in solar cooker?
   a. Plane b. Convex c. Concave d. Flat
4. A wind turbine converts the wind kinetic energy into
   a. heat. b. electricity. c. thermal energy. d. solar energy.
5. In making soap, when lye is completely dissolved, the solution is left to cool to
   a. 50°C. b. 100°C. c. 5°C d. 10°C

B. Short questions

1. What is the most important material in toothpaste?
2. Why does milk turn into plastic when vinegar is added to it?

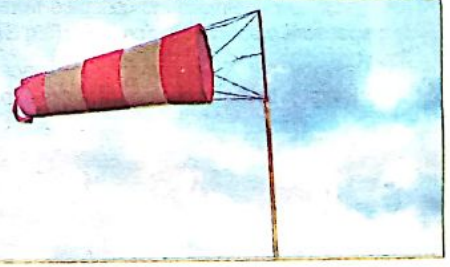
3. What is saponifaction?
4. Why it is better to use concave mirror rather than convex mirror in solar cooker?
5. What are the advantages and disadvantages of using a solar cooker? Are there places where solar cookers would have limited utility?
6. What potential you see for the solar cooker to be used in Pakistan?
7. When can wind power be used?
8. Why might engineers be interested in developing wind power?
9. If you want to install a windmill for your home, where will you place your wind turbine?

C. Long questions

1. What is spherical mirror type solar cooker? How it can be used to cook food?
2. What is a wind turbine? How it is used to produce electricity?
3. What is UPS? Where and how is it used?

Activity 11.9 Design a windsock

Windsocks are used to work out which way the wind is blowing. Design a windsock and install at high point in your school.



D. Project

Prepare Red and Blue Coloured Milk Plastic. Make different shapes with it. Let them dry for two days.

UNIT 12

OUR UNIVERSE

Learning outcomes:

At the end of this unit, students will be able to:

- Explore and understand the terms star, galaxy, milky way and the black holes.
- Compare the types of Galaxies.
- Relate the life of star with the formation of black hole, neutron star, pulsar, white dwarf and red giant.
- Discuss the birth and eventual death of our universe.
- Show how information is collected from space by using telescopes (e.g Hubble space telescope) and space probe (e.g Galileo).
- Describe the advancements in space technology and analyze the benefits generated by the technology of space exploration.

Astronomy is a thrilling field of science. The historical record shows that astronomy has fascinated humans from thousands of years. It still excite us with ideas like how we can travel in space? Are there other planets with life in it? What are black holes?

The universe is the whole of space and all the stars, planets, and other forms of matter and energy in it. In the night sky we see stars, they are huge balls of very hot gas that emit light and other radiation. Sun is also a star but it appears different because it is close to us as compared to other stars.

A galaxy is an extremely large collection of stars bound together by mutual gravitational attraction. Galaxies are the basic units in the structure of the universe. The Sun is part of an estimated 200 billion stars that are held together by gravitational attraction in a galaxy known as Milky Way galaxy.

The Universe is incredibly huge, it contains billions of galaxies, each containing millions or billions of stars. It would take a modern jet fighter more than a million years to reach the nearest star to the Sun. Traveling at the speed of light (300,000 km per second), it would take 100,000 years to cross our Milky Way galaxy alone.

DO YOU KNOW?

How distances in space are measured?

Most objects in space are so far away and big, that using SI unit of distance (metre) is not practical. Instead, to measure distances we use light-years. A light-year is the distance that light can travel in one year. Light moves at a speed of about 300,000 kilometres (km) each second. So in one year, it can travel about 10 trillion km. More precisely, one light-year is equal to 9,500,000,000,000,000 metres. At this speed the light only takes about eight minutes to reach from sun to earth. So the sun is 8 light minutes away from earth. After sun the nearest star to earth is Alpha Centauri whose distance is 4.5 light years. The most distant known object from Earth is 32 billion light-years away.

12.1 GALAXIES

A galaxy is a huge collection of gases, dust, and billions of stars and their solar systems, all held together by gravity.

There are thought to be over 2 trillion galaxies in the observable part of the Universe having different sizes, shapes and colours, with each galaxy, on an average containing about 100 billion stars.

Stars are both scattered throughout space or are grouped into clusters in the form of galaxies. We have discovered that most galaxies also form a group called a cluster. Our Milky Way is part of a group of about 40 galaxies known as the Local Group. Galaxies can be broadly classified into three main types spiral galaxies, elliptical galaxies and irregular galaxies.

Spiral galaxies

Spiral galaxies are the most common type in the universe. Our Milky Way is a spiral galaxy, as is the rather close-by Andromeda Galaxy. Spiral galaxies are large rotating disks of stars and the central bright region at the core of a galaxy is called the 'galactic bulge'. Many spirals have a halo of stars and star clusters above and below the disk.

Figure 12.1 A Spiral Galaxy Andromeda

Elliptical galaxies

Elliptical galaxies are roughly egg-shaped (ellipsoidal) and have no galactic bulge at their centres. Most elliptical galaxies contain old stars as there is little new star formation occurring in them. Elliptical Galaxies can have as few as a hundred million to perhaps a hundred trillion stars, and they can range in size from a few thousand light-years across to more than a few hundred thousand.

Figure 12.2 An Elliptical Galaxy ESO-305-G004

Irregular galaxies

Irregular galaxies are as their name suggests are irregular in shape. They have no definite shape, however like all galaxies, they are in constant motion as a group. Such irregularities in spiral and elliptical galaxies are also observed.

Figure 12.3 Irregular Galaxy NGC 1569

12.2 THE MILKY WAY GALAXY

Our own solar system is a small part of the Milky Way galaxy shown in figure 12.4, just one of many observable galaxies. Milky Way galaxy is larger than average galaxies, both in its number of stars and dimensions.

Figure 12.4 Milky way Galaxy

Activity 12.1 Sky map mobile app

- The sky changes every night. Star maps are a great way to identify what you are looking at in the sky. Here are some ways to get one:
- Get a free star map app, such as SkyView or Sky Map. Point your smart phone at the sky and the app tells you what you are pointing at.
- Search the internet for a star map for your location in the current month.
- Look up a guide about the current night sky, such as Scitech's Sky Tonight.
- Use your star map to look for the star Alpha Centauri. It's near the Southern Cross constellation. This is the closest star to us (after our Sun).

Milky Way galaxy contains roughly 400 billion stars. It has a diameter of about 100,000 light years and a thickness of about 2000 light years in the arms. Its central bulge about 10,000 light years across. Our Sun, which is a star like many others, is located about halfway from the galactic center to the edge, some 26,000 light years from the center as shown in figure 12.5.

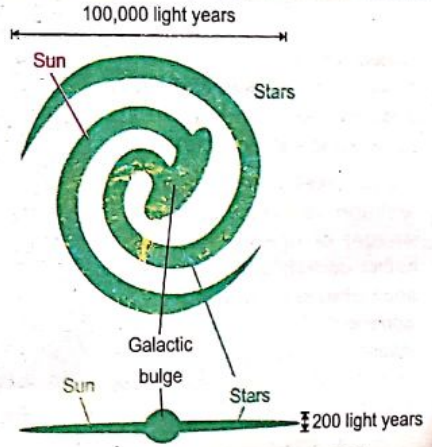


Figure 12.5 - Dimensions of Milky way Galaxy

INTERESTING FACTS

Although other, smaller galaxies are closer to our Milky Way, the Andromeda Galaxy is the largest galaxy in local group, and on a clear night it can be observed with the naked eye. Sometimes galaxies get too close and smash into each other. Our Milky Way galaxy will someday bump into Andromeda. But don't worry. It won't happen for about five billion years. But even if it happened tomorrow, you might not notice. Galaxies are so big and spread out at the ends that even though galaxies bump into each other, the planets and solar systems often don't get close to colliding.

12.3 THE LIFE OF STARS

The stars seem to appear still, we in our life will not see any major change. However, many stars move and their motion can be detected. The Sun was formed about 4.5 billion years ago. Many stars came into being before and many others formed after the Sun was formed. Through telescopes we can now see that stars have a life cycle, they are born, radiate energy, expand, possibly explode, and then die.

Birth of stars

Stars are born (forming out of matter), when gaseous clouds contract due to the pull of gravity. As the particles merge, their kinetic energy increases, which starts nuclear reactions. These reactions change light elements into heavier ones and release energy in the process and stars appears to glow.

In a star (like our Sun), the nuclear reaction releases very large amount of energy, this stops further contraction due to gravity and stabilizes the size of star. Our Sun spent 30 million years to reach stability, and is expected to remain there about 10 billion years since its birth.

Figure 12.6 Gas clouds forming stars

Death of star

Death of star occurs when the fuel for nuclear reaction (lighter elements) is used up. A dying star collapses under its gravity as the energy flow from the core of the star stops. Nuclear reactions outside the core cause the dying star to expand outward in the "red giant" phase before its collapse (figure 12.6).

Figure 12.6 Red giant phase of star death

After the formation of red giant, the core of the star ends up as one of the following three types:

- White Dwarf
- Neutron star (or pulsar)
- Black hole

The initial mass of the star plays an important role when it is at last stage. Depending upon the mass, the following phenomenon occurs.

A. Formation of white dwarf

If the initial mass of the star is less than or equal to the mass of the Solar mass (mass of the sun), the red giant becomes white dwarf. Its size reduces to the size of the earth.

It's colors changes from white to yellow and then to red and finally it becomes black and is known as black dwarf. The Sun is about 4.5 billion years old, it has used up about half of its nuclear fuel after about 5 billion years will be a white dwarf. The nearest known white dwarf is Sirius B located at 8.6 light years.

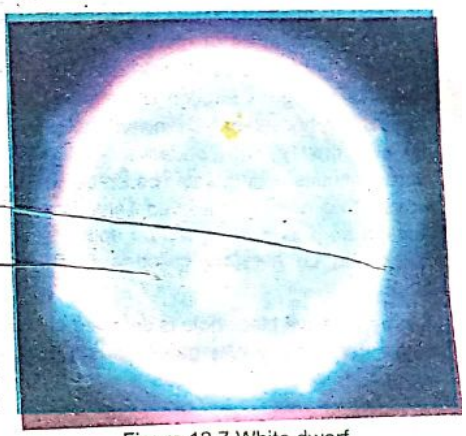


Figure 12.7 White dwarf

B. Formation of Neutron star

If the initial mass of the star is between one to five times of solar mass, the red giant becomes a neutron star. The contraction of the star continues until it become so dense, such that it is composed almost entirly of neutrons.

A neutron star is so dense that a teaspoon of neutron star material would weigh about 10 million tons. The diameter of a neutron star is estimated to be 10-20 kilometers, about a size of an average city.

A pulsar is a highly magnetized rotating neutron star that emits beams of electromagnetic radiation out of its magnetic poles.

This radiation can be observed only when a beam of emission is pointing toward Earth, and is responsible for the pulsed appearance of emission. This produces a very precise interval between pulses that ranges from milliseconds to seconds for an individual pulsar.

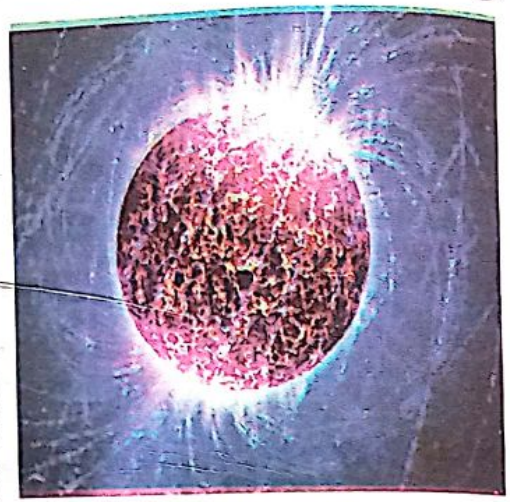


Figure 12.8 Neutron Star

C. Formation of Black Hole

If the initial mass of the star is more than five times the mass of the solar mass, the red giant becomes a black hole. The massive star goes through uncontrolled contraction because of the inward pull of its own gravity. The contraction of the star continues until the star becomes so dense that nothing not even light, can escape from its gravity. Thus it appears black and is therefore called a black hole.

A supermassive black hole is detected at the center of Milky Way galaxy, which is about 4.3 million solar masses.

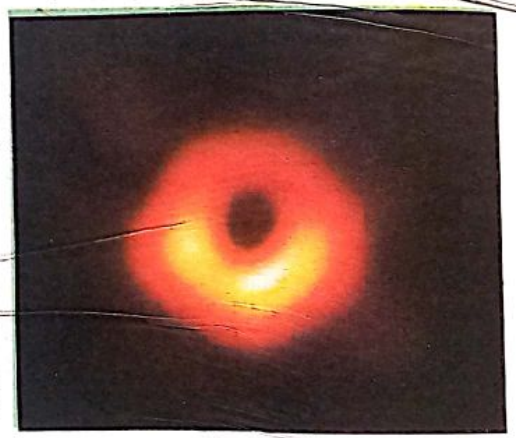


Figure 12.9 Black Hole

Teaching Point: All neutron stars emits beam of electromagnetic radiations from its poles. However, neutron stars are only observed as pulsars if earth happen to lie in the path of this beam.

12.4 THE LIFE OF SUN

Like other starts, our sun is energized by nuclear reactions at its core and shine by burning hot gases which are held together by gravity.

Birth of the Sun

About 4.6 billion years ago large cloud of gas (mostly hydrogen) and dust (microscopic rocks) in our milky way galaxy formed our sun. Within the clouds were hundreds of condensed, cold lumps of gas and dust which collapsed under its own gravity by a disturbance, probably from a blast wave from a nearby stellar explosion. One of this lump which collapsed to became our Sun, produced great pressure and density at the center, and the friction of the in-falling particles released heat.

This heat resulted in a nuclear reaction that will go on for billions of years. The outward pressure created by this nuclear reaction counterbalanced the inward pressure of gravity, and when the two canceled each other out, the natal lump of dust and gas stopped collapsing. This process took about 100 million years and the Sun was born. In the process along with our sun many other starts were formed, but sun broke up early from them in the first 100 million years of its life.

DO YOU KNOW?

Are we looking at past, when we observe stars ?

When we look at the closest star outside our solar system, Alpha Centauri, we are really looking into the past. This star is 4.3 light-years away, which means that the light arriving here today was emitted 4.3 years ago. What we see, in fact, is the past. When we look at our neighboring galaxy, Andromeda, we are really seeing it as it was 2.4 million years ago. Many of the stars we can observe today ceased to exist years ago. Many galaxies that we see are not at that point right now.

Death of the Sun

The nuclear reaction at the core of the sun will continue for another 5 billion years. What will happen when the Sun runs out of nuclear fuel? The sun will grow into red giant phase, having its radius grow by 30 times. This red-giant stage will last for about 2 billion years. In this phase it will come close to the orbit of earth radiating thousands of times more energy, perhaps evaporating all its atmosphere.

At the end of red giant phase the sun will turn into white dwarf stage and will glow white-hot for a near-eternity.

12.5 INFORMATION FROM SPACE

Have you ever wondered how space exploration impacts your daily life? Space exploration has nearly no limit to how far humankind can adventure as our technology advances. We explore space by different means, few of which will be discussed here.

Telescope

A telescope is a tool that astronomers use to see far away objects enlarged. Telescopes make use of curved mirrors and glasses (called lenses) to gather and focus light from the night sky.

The bigger the mirrors or lenses, the more light the telescope can gather. Light is then concentrated by the shape of these mirrors or lenses which is what we see when we look into the telescope. The mirrors and lenses must be almost perfect and have to be just the right shape to concentrate the light. They can't have any spots, scratches or other flaws. If they do have such problems, the image gets warped or blurry and is difficult to see.

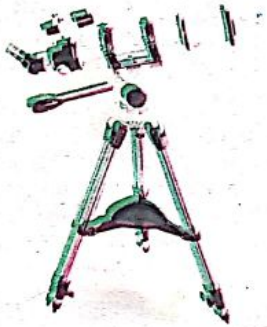


Figure 12.10 Optical Telescope

Apart from visible light telescope, which are termed as optical telescopes, scientist have also made use of other part of the spectrum to observe the universe. These broad spectrum telescopes make use of radio waves, ultra violet, infra red, X-rays and even gamma rays.

Space telescopes

A space telescope is an instrument located in outer space to observe distant planets, galaxies and other astronomical objects, like the Hubble Space Telescope.

A telescope in space is above Earth's atmosphere. This lets us see more clearly and also lets us see kinds of light, like ultraviolet and X-rays, that are blocked by the atmosphere. The Hubble Space Telescope, named after astronomer Edwin Hubble, was launched into orbit in 1990.

The Hubble telescope is one of the largest telescope, it is constantly been upgraded and aging parts were replaced, which has increased its capability and life time.

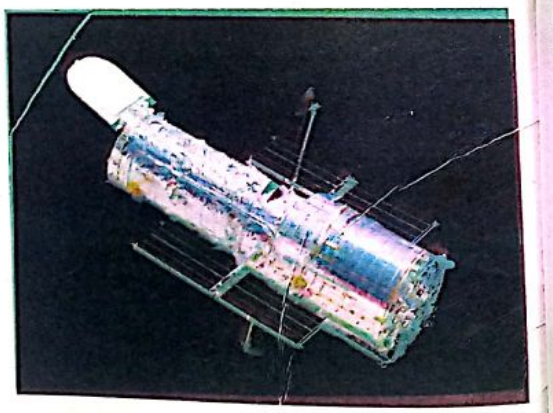


Figure 12.11 Hubble Space telescope

INTERESTING FACTS

The James Webb Space Telescope (JWST) is the largest telescope ever flown in space. It is designed to observe some of the oldest and most distant objects and events in the Universe, including the first stars and formation of the first galaxies. It will also provide atmospheric details about planets other than solar system, for the potential habitability.

James Webb Space Telescope

Space probes

A space probe is a space vehicle (without having astronauts in it), that is launched into space to explore universe. Space probes are used because they make measurements that are difficult to achieve on earth, secondly they can be designed not to return back.

Figure 12.12 Space probe Galileo

Scientists have sent probes in many directions in space, just like space probe Galilio. It was the first space craft to orbit and give information about planet Jupiter, its moons and rings. It was launched on October 1989, it arrived close to Jupiter in December 1995.

At the end of Galileo's life, in September 2003, the probe was deliberately crashed into Jupiter.

Space probes are designed to operate on their own, gathering data and sending it back to Earth for scientists to analyse.

INTERESTING FACTS

The Hubble Space Telescope (HST) has impacted astronomy more than any other object, person, or event in history, even more than Galileo. It can point to celestial objects with amazing accuracy, comparable to pointing a laser pointer on the tip of a pencil that is 2 km away.

Some space probes equipped to carry other self-sufficient devices to increase its field of investigation. To study an astronomical object we can design a space probe in many different forms, such as space probe could be placed in orbit around it, space probe can be made to land on its soil, or space probe may be sent just to impact it.

Probes have travelled toward many of the planets in our solar system, toward our Sun, and even off beyond the orbit of Pluto, like Voyager 1. It has traveled further in space than any human-made object.

DO YOU KNOW?

The Space and Upper Atmosphere Research Commission (SUPARCO) also known as the Pakistan Space Agency of the Pakistani government, responsible for nation's public space program.

Last fifty years of human and robotic activity in space have produced societal benefits that improved the quality of life on Earth. The artificial satellites sent in space has improved telecommunications (Internet and television broadcasts) and weather forecasting.

Universe is vast and there are hidden dangers which could badly affect the life on earth. Only in our solar system, there are asteroid and comet threats which could devastate our planet in case of an impact. Exploring space gives us an opportunity to locate these hazards and to prepare an encounter in advance.

Key Points

- A galaxy is a huge collection of gases, dust, and of stars and their solar systems.
- Our own solar system is a small part of the Milky Way galaxy.
- Stars are huge balls of hot gases that emit light and other radiation.
- Stars are born, when gaseous clouds contract due to the pull of gravity.
- Stars death occurs when the fuel for nuclear reaction (lighter elements) is used up.
- Cosmology is the study of the character and evolution of the universe.
- The sun was formed of stellar gas and dust, and will turn into a white dwarf.
- Telescope is a tool that astronomers use to see far away objects enlarged.
- A space probe is a space vehicle (without having astronauts in it), that is launched into space to explore universe.

UNIT 12 OUR UNIVERSE

END OF UNIT ASSESSMENT

A. MCQs (Choose the correct option)

1. The distances in space are measured in
   A. metres. B. miles. C. light years. D. kilometres.
2. Milky Way galaxy is classified as
   A. spiral galaxy. B. elliptical galaxy. C. irregular galaxy. D. spherical galaxy.
3. With no or very little star formation, galaxy is called
   A. spiral. B. elliptical. C. irregular. D. spherical.
4. When the mass of star is equal to our sun it will turn into
   A. white dwarf. B. neutron star. C. black-hole. D. singularity.
5. During star formation the stars are prevented to collapse under gravity by
   A. black holes. B. other stars. C. mass of gases. D. nuclear reactions.
6. A pulsar is type of
   A. white dwarf. B. neutron star. C. black hole. D. red giant.
7. To form a black hole, the initial mass of the star in solar masses should be
   A. 0.5 B. 1 C. 3 D. 7
8. The total life of sun (from birth to its death) is
   A. 100 million years. B. 4.6 billion years.
   C. 5 billion years. D. 10 billion years.
9. Optical telescopes make use of
   A. X-rays. B. infra red light. C. visible light. D. radio waves.
10. The unmanned object launched into space to study celestial objects is
    A. steatite. B. star. C. space probe. D. space telescope.

B. Short questions

Give short answers to the following questions

1. Why are distances in space often measured in light years?
2. Is our sun in motion through space?

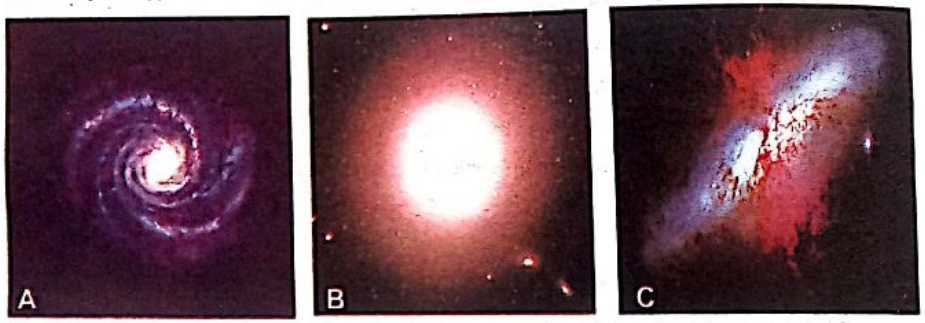
3. What is the source of the Sun's energy?
4. Why the Sun will not become a black hole?
5. What are the advantages of designing Space probes for not to return back to earth?

C. Long questions

1. What are galaxies? Explain different types of galaxies.
2. How do stars form? What stages does a star pass through? Why do some stars end up as white dwarfs, and others as neutron stars or black holes?

D. Structured response questions

1. Identify the type of each galaxy from the images given below.



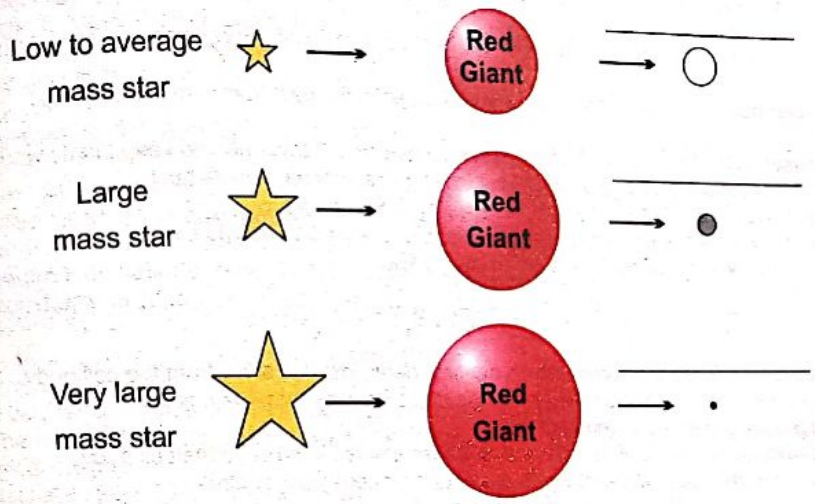
Answer the following Questions

i. Which type of galaxy is the largest as well as the smallest?

ii. Which Galaxy has no 'galactic bulge'?

iii. Milky way galaxy falls close to which category of galaxies?

2. **Consider the diagrammatic representation of fate of dying star depending upon its mass and label the end results.**



The diagram is not drawn to scale.

E. Project work: Designing Space Probe

In this project students will play the role of scientists or engineers in designing a new space probe to explore a planet or moon. Class will be divided into three groups.

Group I: Group I will choose a planet or moon as a destination for the space probe, by giving a unique name for their space probe. They will search the internet to review the weather factors on that planet, including possible extreme weather. They would list any considerations they can imagine related to the environment and weather on the planet, including what the space probe will look like, what size it will be, and how their probe will travel the distance to reach that destination. They would consider how they might need to modify instruments to collect information far from Earth and to withstand the weather on their selected planet.

Group II: This group will design the space probe. They will sketch or model a space probe that lands on or hovers above the chosen planet. They will be required to include the following:

- three instruments that will measure at least two different weather conditions
- labels of the parts of the probe or design for their model
- expected measurements of the finished product and time-line of project.

Group III: This group will review the work of the group I and II and critique their project keeping in view the cost effectiveness and design consideration of the project.

GLOSSARY

Unit 1

Afforestation: plantation of trees on a land with no earlier forest cover.
Ecosystem: An ecological system formed by the interaction of living organisms and their non-living environment.
Epiphytes: small plants which grow on tree to get better light without causing any harm to host tree.
Fossil fuels: natural fuels like coal, gas and oil formed in the past from remains of living organisms.
Greenhouse: a structure made up of transparent sheet which traps heat to keep plants warm.
Parasite: an organism which gets benefit but in return causes harm to its host.
Pollution: contamination of environment with harmful substances.
Predator: an organism which actively hunts and kills an animal to use as food.
Prey: an animal which is attacked and killed by predator.

Unit 2

Axon: cytoplasmic fibres of neurons which transmit nerve impulse away from the cell body.
Brain stem: midbrain, pons and medulla oblongata collectively form brain stem.
Cranium: a bony protective covering of brain.
Dendrite: cytoplasmic fibres of neurons which transmit nerve impulse to the cell body.
Involuntary action: body functions which are not under conscious control.
Myelin sheath: a protective covering around axon fibres.
Nerve impulse: a wave of electrochemical changes along the neuron fiber which conducts messages.
Nerve: many fibers of sensory neurons or motor neurons or both protected in a layer of connective tissue.
Neuron: cells which are functional unit of nervous system which transmit messages in the body in the form of nerve impulses.
Reflex action: sudden involuntary activities.
Reflex arc: a pathway on which nerve impulse travels from receptor to effector.
Voluntary action: body functions which are under conscious control.

Unit 3

Centromere: a point where two chromatids of a chromosome are linked to each other.
Crossing over: the exchange of segments between identical chromosomes during prophase I of meiosis.
Gene: a unit of biological information is called a gene.
Genetics: the study of genes and their role in inheritance
Inheritance: the transfer of characteristics from parents to offspring.
Meiosis: a type of cell division in which a parent cell divides twice to form four daughter cells each with half the number of chromosomes as compared to the parent cell.
Mitosis: a cell division in which parent cell divides to form two daughter cells each with same the number of chromosomes as in parent cell.
Nucleotide: a unit of DNA molecule made up of deoxyribose sugar, a nitrogenous base and a

phosphate group.
Variations: the differences among the members of same species.

Unit 4

Allergen: a substance which causes some allergy
Biodegradable: a substance which can be decomposed by bacteria fungi.
Biotechnology: the use of living organism and their processes to make products useful for human.
Enzyme: biological catalyst which speeds up reaction in a living system without being consumed.
Fermentation tank: a device which provides optimum conditions for maximum growth of microorganisms.
Genetically modified organism (GMO): an organism having foreign gene inserted in it. Such organism is also called transgenic organism.
Haemophilia: a hereditary disorder in which blood fails to clot after injuries.
Mineral deficiency disease: a disease which is caused by deficiency of some essential mineral.
Vaccine: a substance used to stimulate the production of antibodies thus provides immunity.

Unit 5

Group: The vertical columns in the Periodic Table are called groups.
Isotopes: The elements having same number of electrons in their outermost shell, possess similar chemical properties.
Metals: Metals are shiny, ductile, malleable, good conductor of heat and electricity and possess high melting points.
Non-metals: Non-metals have dull appearance, non-ductile, non-malleable, bad conductor of heat and electricity and possess low melting and boiling points.
Period: The horizontal rows in the Periodic Table are called periods.
Periodic Table: A table showing the systematic arrangement of elements is called periodic table.

Unit 6

Burning: Burning is a chemical change.
Chemical reaction: A chemical change is called a chemical reaction.
Chemical equation: The chemical equation is the representation of a chemical reaction.
Covalent bond: The bond formed by mutual sharing of electrons between two atoms is called covalent bond
Decomposition reaction: In a decomposition reaction one reactant produces two or more products.
Displacement reaction: In a displacement reaction a more reactive element takes the place of less reactive element.
Double displacement reaction: In a double displacement reaction two atoms or group of a atoms exchange their places
Endothermic reaction: In an endothermic reaction heat is absorbed.
Exothermic reaction: In an exothermic reaction heat is evolved.
Ionic bond: The force of attraction that binds oppositely charged ions is called ionic bond.
Law of conservation of mass: Law of conservation of mass states that the total mass of reactants and products is conserved.

Synthesis reaction: In a synthesis reaction, two or more reactants combine to form a single product.

UNIT 7

Acid: An acid is a substance that dissolves in water to produce hydrogen ions (H^+).
Alkali: An alkali is a substance that dissolves in water to produce hydroxide ions (OH^-).
Antacids: Antacids are compounds that neutralise excess acid in our stomach, when suffering from indigestion.
Neutralisation reaction: When an acid reacts with an alkali, it forms salt and water. This type of reaction is known as neutralisation reaction.

UNIT 8

Balanced forces are equal in magnitude and opposite in direction.
Buoyancy or up-thrust is an upward force exerted by a fluid that opposes the weight of an immersed object.
Fluid pressure the force per unit surface area at any point in a gas or liquid
Force a push or pull capable of changing the state of motion of an object; a force has magnitude (strength) as well as direction
Hydraulic elevator: An elevator or lift that is powered by electric motors that pump hydraulic fluid to raise a cylindrical piston.
Net force the resulting force due to combination of different forces; if a net force is zero, all the forces have canceled one another and there is not an unbalanced force
Pascal is unit of power, when one newton of force applied over an area of one meter square ($1m^2$).

Pressure the force acting on a unit area of a surface.
Unbalanced Forces the force applied in one direction is greater than the force applied in the opposite direction.

UNIT 9

Absorption of light is when light interact with matter and disappears, the energy in light is converted into other forms of energy such as thermal energy.
Center of curvature is the center of the sphere of which the mirror is formed.
Colour is the quality of an object or substance with respect to light reflected by the object.
Dispersion of light is the splitting of light into different colours.
First Law: The incident ray, the reflected ray, and the normal to the surface all lie in the same plane.
Focus point is the point at which a parallel beam of light is "focused" after reflection in the mirror
Laws of reflection describe the behaviour of the incident and reflected rays.
Pole: is the midpoint of the spherical mirror formed.
Principal axis: is a straight line drawn through the center of curvature and the pole.
Radius of curvature is the radius of sphere of which the mirror is a section.
Ray of light is an idealized model of *light*, which is drawn as a straight line.

Real image the representation of an actual object, produced when the light rays arising from a single source converge at a particular point
Reflection of light is when it interact with matter and bounce off its surface.
Refraction of light is the bending of a light when it enters a medium where its speed is different.
Second Law: The angle of reflection equals the angle of incidence.
Speed of light is the distance light travels per unit time. Only in one second, light travels a distance about 300,000 kilometres.
Spherical mirror is a mirror which has the shape of a piece cut out of a spherical surface.
Transmission of light is when light interact with matter and pass through it
Virtual image is the image that only appear to be formed at a position behind a mirror

UNIT 10

Ampere a flow of one coulomb of charge per second.
Circuit breaker is an electrical safety device designed to protect an electrical circuit from damage caused by an overcurrent or short circuit.
Current is a stream of charged particles, such as electrons or ions, moving through an electrical conductor or space
Earth wire a wire connecting an appliance to ground.
Electric bell is a *bell* that functions by means of an electromagnet.
Electric shock occurs if current flows from an electric circuit through a person's body to earth.
Electrical power is the rate, per unit time, at which *electrical energy* is transferred by an electric circuit.
Electromagnet is a type of magnet in which the magnetic field is produced by an electric current.
Fuse is an electrical safety device that operates to provide overcurrent protection of an electrical circuit.
Ohm is the resistance between two points of an electrical conductor transmitting a current of one ampere when the potential difference is one volt.
Overloading when too much current passes through electric wires.
Resistance is a measure of the opposition to current flow in an electrical circuit.
Short circuit is an electrical circuit that allows a current to travel along an unintended path with no or very low electrical resistance
Speaker is a device that converts an electrical signal into sound.
Voltage is the amount of potential energy between two points on a circuit.
Volts the electric potential difference per *unit* charge between two points in an electric field.
Watt is equal to one joule of work performed per second.

UNIT 11

Spherical mirror solar cooker is a *mirrored* surface with high reflection is used to concentrate light from the sun into a small *cooking* area.

UPS or Uninterruptible Power Supply is an electrical apparatus that provides emergency power to a load when the input power source or mains power fails.

Wind turbine is a device that converts the wind's kinetic energy into electrical energy.

UNIT 12

Big bang theory is an explanation that shows the origin of the stars, planets, galaxies and the Universe as a whole.

Birth of star: Star are giant spheres of superhot gas made up mostly of hydrogen and helium.

Black hole is a region of space where gravity is so strong that nothing — no particles or even light — can escape from it.

Death of star: Death of star is when the fuel for nuclear reaction (lighter elements) is used up.

Galaxy is a group of stars, clouds of gas, and dust particles that move together through the universe.

Galileo is space probe that studied the planet Jupiter and its moons

Hubble space telescope is a large space telescope.

Light-year is the distance that light can travel in one year.

Milky Way is the *galaxy* that includes *our* Solar System

Neutron stars are extremely dense, compact stars thought to be composed primarily of neutrons.

Pulsars are rotating neutron stars observed to have pulses of radiation at very regular intervals

Red giant is a dying star in the final stages of stellar evolution.

Space probe is an unmanned space mission, usually a small spacecraft sent out to find out information about a planet or other far away thing

Star is giant spheres of superhot gas made up mostly of hydrogen and helium.

Telescopes A telescope is an instrument that allows people to see distant objects.

White dwarfs are the hot, dense remnants of long-dead stars. They are the stellar cores left behind after a star has exhausted its fuel

ACKNOWLEDGMENTS

Unit 1

Fig 1.3: NASA Climate Change, Fig 1.4: Garden-loveToKnow, Fig 1.6: Chegg, Fig 1.7: The Sun, Fig 1.9: Shutterstock, Fig 1.10: Last Minute Day Tour, Fig 1.11: New Scientist, Fig 1.13: Quora, Fig 1.17: Twitter, Fig 1.20: India MART, Fig 1.21: NREL, Fig 1.22: iStock, Fig 1.24: Sky News, Fig 1.25: Geographical Magazine,

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Unit 4

http://www.youtube.com

http://ncbi.nlm.nih.gov

http://www.generationgenius.com

Unit 5

Periodic table of elements.byjus.com

https://www.ducksters.com/

Unit 6

Chemical reactions Britannica.com

http://britannica.com

https://www.encyclopedia.com/

Chemical bonding http://www.youtube.com

Unit 7

http://www.youtube.com

http://britannica.com

UNIT 8:

https://www.ducksters.com/science/physics/pressure.php

https://www.teachoo.com/10079/3018/What-is-Atmospheric-Pressure-/category/Concepts/

https://www.encyclopedia.com/science-and-technology/physics/physics/pressure

UNIT 9

https://mocomi.com/reflection-and-refraction-of-light/

https://www.synopsys.com/optical-solutions/learn/optics-for-kids/lenses.html

https://javalab.org/en/mirrors_en/

https://micro.magnet.fsu.edu/primer/java/mirrors/convexmirrors/index.html

UNIT 10

https://www.explainthatstuff.com/electricity.html

https://byjus.com/physics/current-electricity/

https://byjus.com/power-calculator/

UNIT 11

https://www.jreda.com/content/104/Solar%20Cooking%20System

https://insteading.com/blog/solar-cooker/

https://mocomi.com/how-do-wind-turbines-work/

https://lisbdnet.com/how-do-windmills-work-for-kids/

https://www.techtarget.com/searchdatacenter/definition/uninterruptible-power-supply

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https://www.nasa.gov/kidsclub/index.html

https://www.esa.int/kids/en/learn

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6.	Activities, projects and additional work is suggested for reinforcement of concepts.	
7.	Assessment achievements are thought provoking and comprise cognitive, psychomotor and effective skills.	
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Page No.	Observation/comments	Suggested amendment along with rationale

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